# GUIDE TO RESEARCH LOGISTICS IN THE NORTHWESTERN HAWAIIAN ISLANDS

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# LIST OF TELEPHONE NUMBERS FOR NWHI LOGISTIC INFORMATION

| | | |
|---|---|---|
| U.S. Coast Guard Logistics | 546-5522<br>546-5523<br>546-5524 | |
| U.S. Coast Guard Aids to Navigation | 546-7130 | |
| Military Airlift Command passenger reservations | 449-5294 | |
| Military Airlift Command information | 449-1752 | |
| J. Brent Giezentanner, U.S. Fish and Wildlife Service Refuge Manager | 546-5608 | |
| Ron Walker, Wildlife Branch Chief, Hawaii Division of Fish and Game | 548-4002 | |
| Skip Naftel, EASY RIDER | 734-0376 | |
| Tom Hida, National Marine Fisheries Service, TOWNSEND CROMWELL | 533-4110<br>946-2181 | Kewalo Basin<br>Dole Street Lab. |
| J. Frisbee Campbell, Scientific Coordinator of Marine Operations, Hawaii Institute of Geophysics | 948-7654 | |
| Richard Grigg, Coordinator, Sea Grant NWHI Fisheries Investigations Program | 247-6631<br>948-7429 | Coconut Island<br>UH |
| Steve Dollar | 948-7429 | |
| Leighton Taylor, Waikiki Aquarium | 923-9741 | |
| Jed Hirota | 948-7469<br>247-6631 | |
| Tim Smith | 948-8677 | |
| George Balazs | 247-6631 | |
| Jack Davidson, Director, UH Sea Grant College Program | 948-7031 | |
| John Craven, Marine Affairs Coordinator | 548-6262 | |
| Stan Swerdloff, Marine Affairs Coordinator's Office | 548-6262 | |
| Robert Skillman, National Marine Fisheries Service | 946-2181 | |

# INTRODUCTION

In 1977, the National Marine Fisheries Service of the U.S. Department of Commerce, the Fish and Wildlife Service of the U.S. Department of the Interior, and the Department of Land and Natural Resources of the State of Hawaii entered into a five-year tripartite cooperative agreement to conduct a detailed survey and assessment of the biological resources of the Northwestern Hawaiian Islands (NWHI). This assessment will provide a foundation on which management decisions can be made concerning the long-range use and preservation of living natural resources.

To augment the tripartite investigation, the University of Hawaii Sea Grant College Program, NOAA, is proposing a multi-project program to investigate the population dynamics of specific fishery resources in the NWHI. The proposed studies, which will focus on the overall fertility of the area, will include investigations of the primary and secondary productivity of the entire Hawaiian Archipelago, as well as detailed investigations of the ecological relationships between various important commercial and protected species. The Sea Grant studies will extend over a period of several years and will involve numerous principal investigators, field personnel, technicians, graduate students, and part-time student assistants, many of whom will begin working in the program after its inception.

There is no existing publication on the logistics of conducting research in the NWHI. The purpose of this guide is to serve as a concise assemblage of information that will acquaint the researchers with the where, when, and how of working in the NWHI, thus eliminating a duplication of effort and the loss of time to re-investigate the basic logistics. Included is information on how to get there (by ship or air service), the location and brief description of each island, general climatic conditions, living and surface support facilities, directions for obtaining the necessary permits and clearances to work in these areas, and a summary of the legal intricacies involving jurisdiction of the NWHI. Also included are references to the literature and documents that provide information on the NWHI.

Some of the information contained in this guide was gathered during a site visit to Kure Atoll and Midway Islands on January 25-27, 1978 provided through the courtesy of the U.S. Coast Guard. A site visit to French Frigate Shoals, the only other inhabited island of the NWHI, was not possible due to cessation of air transportation to the atoll. Other valuable information was acquired through personal communication with government and military authorities and researchers who have worked in the NWHI in the past, as well as reviews of existing literature. The information contained herein should not be considered a final statement since the policies and procedures of many of the agencies involved are constantly changing. The information in this guide will be updated as these changes occur. For this reason the pages are not numbered.

# LEGAL STATUS OF THE NORTHWESTERN HAWAIIAN ISLANDS

Currently, jurisdiction over the NWHI is a complex issue involving federal, state, and military authorities. The following is intended to be a brief summary of the existing legal status of the NWHI and of the definitions applied by the various agencies. Some background information concerning the legal constraints of working in the NWHI and information on the types of permits and clearances necessary to work in the islands are provided.

## AREAS OF JURISDICTION

### Federal Jurisdiction

#### Hawaiian Islands National Wildlife Refuge (HINWR)

The Hawaiian Islands National Wildlife Refuge (Figure 1) is a series of rocky islands, islets, atolls, and near-atolls in the remote northwestern segment of the Hawaiian Archipelago. The refuge, which is located to the northwest of Kauai and Niihau, extends over 1,666 km and includes eight major land masses: (1) Nihoa Island, (2) Necker Island, (3) French Frigate Shoals, including 14 coral islets within the lagoon, (4) Gardner Pinnacles, (5) Maro Reef (entirely submerged except for a single rock extending about 2 feet above high water), (6) Laysan Island, (7) Lisianski Island, and (8) Pearl and Hermes Atoll. Kure Atoll and Midway Islands are not part of the refuge (Figure 1).

The "Hawaiian Islands Reservation" was established by Executive Order in 1909 by President Theodore Roosevelt to protect native bird colonies from overexploitation by guano mining operations and the plumage industry. Administration of the Hawaiian Islands Reservation was originally vested in the U.S. Department of Agriculture. In 1940, under Presidential Proclamation, the administration of the reservation was transferred to the Fish and Wildlife Service of the U.S. Department of the Interior and the name of the area was officially changed to the Hawaiian Islands National Wildlife Refuge, as it is known today. In 1966 the National Wildlife Refuge Act established Congressional guidelines and direction for the administering of all areas in the National Wildlife Refuge system, including areas for the conservation of fish and wildlife that are threatened with extinction. The Act provided authority to the Refuge Manager relating to management of the system and enforcement provisions to protect the system's resources. The enforcement provisions are listed primarily in Title 50, 16 U.S.C. 668dd-668ee.

#### Research Natural Area designation (1967)

The emergent islands of the Hawaiian Islands National Wildlife Refuge were designated Research Natural Areas in 1967 by the Director of the Bureau of Sport Fisheries and Wildlife, Department of the Interior. This designation was made to preserve the unique island habitats for use as

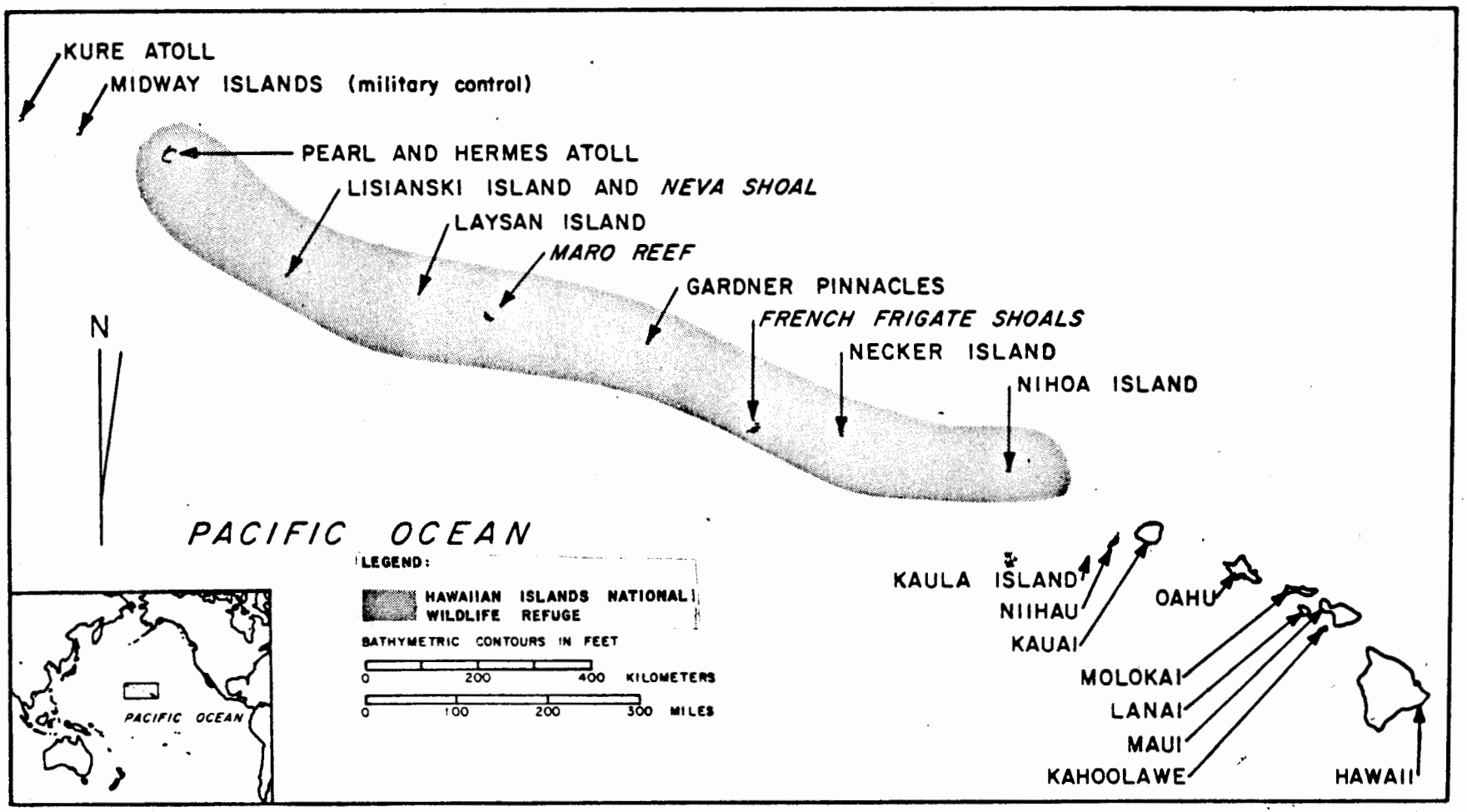



Figure 1. The Hawaiian Islands National Wildlife Refuge

scientific research study areas. As such, the islands are environments where baseline data can be collected for comparison with other areas that have been disturbed by man. Natural climatic and environmental factors predominate on the islands and habitat management and man-induced disturbances are kept to an absolute minimum.

## National Environmental Policy Act of 1969

This Act requires all federal agencies to submit reports on proposals for major federal actions which significantly affect the quality of the human environment. These reports must include (1) the environmental impact of the action, (2) any adverse environmental effects which cannot be avoided should the proposal be implemented, (3) alternatives to the proposed action, (4) the relationship between short-term uses and enhancement of long-term productivity, and (5) any irreversible and irretrievable commitments of resources involved in the proposed action. A request to open the waters within the Hawaiian Islands National Wildlife Refuge (approximately 200,000 acres, as now claimed by the U.S. Fish and Wildlife Service) to further commercial and recreational fishing would require a federal agency to take what may be considered a major action. Data gathered by the tripartite agreement study and the Sea Grant studies will provide invaluable information for the preparation of environmental impact statements regarding the opening of the refuge.

## Wilderness Act of 1964

In 1964 Congress passed the Wilderness Act, requiring the Secretary of the Department of the Interior to report on the status of all federal lands that could be declared wilderness areas. The ensuing U.S. Fish and Wildlife Service wilderness proposal for the NWHI stipulated 304,203 acres as being within the refuge, considering the submerged reefs and shoals as part of the total ecosystem. At the present time, only 1,742 acres of emergent island area have been formally proposed as wilderness. Thus, the proposal, to increase the wilderness area to include submerged reef margins and atoll lagoons as well as emerged areas, has been postponed pending results of the tripartite and Sea Grant studies.

## Marine Mammal Protection Act of 1972

The Marine Mammal Protection Act imposes a moratorium on the taking and importation of marine mammals and marine mammal parts. In addition, it includes certain provisions prohibiting harassment of marine mammals. The Act therefore imposes restrictions on activities of research crews that use the onshore and nearshore areas of the NWHI. The U.S. Fish and Wildlife Service and the Marine Mammal Division of the National Marine Fisheries Service share jurisdictional responsibilities for enforcing the Marine Mammal Protection Act. Operating under the authority of the Act, the Marine Mammal Commission sought to designate a 5-km belt of water surrounding the NWHI as a critical habitat to protect the Hawaiian monk seal. While there is a general consensus that a critical habitat designation is needed, this proposal was shelved as being premature and is awaiting pertinent results of studies assessing the ecological relationships between the monk seal and its environment.

## Fishery Conservation and Management Act (FCMA) of 1976

The Fishery Conservation and Management Act extends the national fishery management jurisdiction from 12 to 200 mi. The major objectives of the Act are (1) to reduce foreign harvesting of fishery resources, except tunas, in the Fishery Conservation Zone (FCZ) (3 to 200 mi) and (2) to impose a management regime within the FCZ. In Hawaii, the Act is administered by the Western Pacific Regional Fisheries Management Council (WPRFMC) and the National Marine Fisheries Service.

Foreign and domestic vessels wishing to fish in the FCZ of the NWHI must apply to the WPRFMC for a permit and are required to report their catches. This means that the Council has exclusive fishery management authority over all fish (except tunas) within a 197-mi zone surrounding the territorial seas of each Hawaiian island as well as the NWHI. The integrity of the state of Hawaii's authority to regulate fishing within its territorial sea of 3 mi from the coastline is not significantly affected by the FCMA.

The establishment of the WPRFMC, a unique partnership of federal, state, and commercial interests, has given fresh impetus to the development of management plans for commercially important species within the FCZ of the NWHI.

## Endangered Species Act of 1973

The Endangered Species Act of 1973 prohibits the taking or harassment of any species declared as endangered in the current Red Book issued by the U.S. Fish and Wildlife Service. Four species of birds residing in the Hawaiian Islands National Wildlife Refuge are currently classified as endangered. These birds are the Laysan duck and finch, the Nihoa millerbird, and the Nihoa finch. In addition, the Hawaiian monk seal has recently been listed as endangered. Since five atolls of the NWHI serve as a breeding and haul-out area for the monk seal, this listing imposes further restrictions upon all research activities in the area.

A second category of species provided for in the Endangered Species Act is that of "threatened species." The status of the green sea turtle as a threatened species has been pending since 1974. Certain HINWR islands are the only remaining nesting sites for these turtles in Hawaii. Presently, Hawaiian green sea turtles are protected from commercial import and export by the Convention of International Trade of Endangered Species (CITES) of which the U.S. is a signatory nation. Also, State Fish and Game Regulation 36 prohibits commercial trade of green sea turtles and places a minimum size limit of 36 inches on turtles taken for private consumption by fishermen with a state-issued permit.

## State of Hawaii Jurisdiction

All of the islands of the Hawaiian Archipelago, with the exception of Midway Islands, are legally part of the state of Hawaii.

State of Hawaii Wildlife Refuge

All emergent lands of the HINWR, including Kure Atoll, were declared a State Wildlife Refuge in 1952. On December 27, 1951, the U.S. Fish and Wildlife Service entered into agreement with the state of Hawaii authorizing the state to designate the lands and water of the Hawaiian Islands National Wildlife Refuge as a sanctuary for birds and wildlife under the resolutions of the Territory of Hawaii. The State Wildlife Refuge is administered by the Hawaii Division of Fish and Game, Department of Land and Natural Resources; permits must be obtained from this agency in order to enter the refuge. While Kure Atoll is a state refuge only, and not part of the HINWR, it is still under the jurisdiction of the U.S. Fish and Wildlife Service and the National Marine Fisheries Service for the purposes of enforcing the Marine Mammal Protection and Endangered Species Acts.

Regulation of fishing in the Leeward Islands

The Department of Land and Natural Resources may limit the number of permits issued to fish within particular areas of the "Leeward Islands" to those persons holding a valid state commercial fishing license. The "Leeward Islands" are defined as those "islands, reefs, and shoals of the Hawaiian Islands chain beginning and including French Frigate Shoals to and including Kure Island." However, two bills (SB 1808 and HB 2100-78) introduced to the Hawaii State Legislature in 1978 seek to extend this area from Nihoa Island to Kure.

Endangered, threatened, and indigenous species

The Department of Land and Natural Resources, through various regulations based on Hawaii statutes, declares it "unlawful to attempt to take, catch, injure, kill, destroy, possess, transport, export, process, sell or offer for sale any indigenous, endangered, or threatened wildlife." Wildlife is defined to be any animal not introduced and the Hawaiian monk seal. The marine turtles (see Endangered Species Act of 1973 under the section on "Federal Jurisdiction"), seabirds, and land birds are listed specifically in various regulations. Permits for scientific research involving these wildlife must be obtained from the State Division of Fish and Game.

## City and County of Honolulu Authority

Under the statutes of the state, the City and County of Honolulu is defined for administrative purposes as including the island of Oahu and the NWHI with the exception of Midway Islands. However, the significance of this designation is legal only and does not enter into any actual management authority.

## Military Authority

Legally, Midway Islands are not part of the United States and therefore not part of the state of Hawaii. Since 1867 Midway Islands have officially been a "possession" of the U.S. It is administered by the U.S. Navy. For this reason there is no real legal authority over civilians on Midway Islands other than the U.S. Attorney General; thus, as such, entry is strictly prohibited unless authorized by the Secretary of the Navy. The Navy also maintains a "Naval Defense at Sea Area," which encompasses all waters within an 8-km boundary of the islands. This defense area is not part of the state or national refuge and is heavily monitored by the Navy. Research vessels are allowed to pass through this area with permission from the Navy.

## BOUNDARIES OF THE NORTHWESTERN HAWAIIAN ISLANDS

Neither the original Presidential Executive Order nor the subsequent Presidential Proclamation dealing with the HINWR, nor the State Board Resolution defining the State Wildlife Refuge contain exact descriptions of the boundaries of the refuge islands. This raises the legal question of whether the refuge is composed of reef, inner lagoons, and submerged buffer areas, or just the emergent portions of the islands. The U.S. Fish and Wildlife Service maintains that the refuge is made up of not only the land that is always out of the water, but also the submerged lands encompassed by fringing reefs and where breaks occur in the fringing reef inside of a line drawn headland to headland. This boundary would eliminate lagoon areas and shallow offshore reefs as potential state fisheries.

Both state and federal scientists agree, at least in principle, that the marine and terrestrial ecosystems in the NWHI are closely linked. One of the primary goals of both the tripartite study and the Sea Grant NWHI fishery resource assessment proposal is to investigate the ecological relationships of the species that inhabit the refuge islands and surrounding waters in order to aid in the ultimate determination of which areas should be designated as refuge and which should be designated for potential fisheries.

Presently, the Department of the Interior has agreed to withhold action to legally define the refuge to include the submerged areas until such time as the tripartite survey is completed and the results known.

# RESTRICTIONS, PERMITS, AND CLEARANCES

## SPECIFIC RESTRICTIONS IN THE HAWAIIAN ISLANDS NATIONAL WILDLIFE REFUGE (U.S. FISH AND WILDLIFE SERVICE)

By authority granted through the Wildlife Refuge Administration Act of 1966, the Refuge Manager of the Hawaiian Islands National Wildlife Refuge stipulates the following conditions and restrictions for entry into the refuge:

1. Access is limited to approved research personnel and is by written permit issued by the Refuge Manager in response to written requests outlining the specific research study plan. This written request must be submitted to:

   J. Brent Giezentanner, Refuge Manager
   U.S. Fish and Wildlife Service
   300 Ala Moana Boulevard, Room 5302
   P.O. Box 50167
   Honolulu, Hawaii 96850
   (808) 546-5608

2. The taking of any plant, animal, fish, coral, or other aquatic organism except for approved research purposes is prohibited unless authorized in writing by the Refuge Manager. Fishing for sport or food purposes within the refuge is also prohibited.

3. No harassment or undue stress can be placed on any organism within the refuge.

4. All clothing and gear must be checked before entry onto the islands and must be free of all foreign plants, animals, or insects.

5. All trash and refuse brought onto the islands must be removed upon departure. No ocean dumping is allowed within refuge boundaries.

6. During certain seasons of the year, critical nesting, pupping, and habitat areas may be placed completely off-limits to all personnel when the Refuge Manager determines that conflicts between human presence and wildlife will significantly harm the resource. Access at one time of year, therefore, does not guarantee access all year long.

7. The Refuge Manager, or his designated representative, may at his discretion remove any persons, equipment, or activities which he deems to be in conflict with the welfare of the refuge and its resources.

8. Camping is allowed only in areas designated by the Refuge Manager.

9. Specific restrictions regarding activities affecting individual species are as follows.

Monk seals. Unless otherwise approved as part of a research project, persons must maintain a minimum distance of 50 ft from all monk seals and 100 ft from females with pups or breeding pairs. During the May through July pupping season, unless otherwise permitted by Special Use Permits, all personnel are prohibited from entry onto French Frigate Shoals (Whale, Skate, Trig, Round, and East Islands); Laysan Island (except for camp site); Lisianski Island; and Pearl and Hermes Atoll (all islands).

Sea turtles. Unless otherwise approved as part of a research proposal, persons must maintain a distance of 50 ft from all turtles and must not approach egg-laying females.

Sea bird colonies (island interior). Generally, most persons will have no need to enter the interior of any refuge island. Those projects which require entry must be approved specifically by the Refuge Manager or his representative; otherwise no other entry into the interiors will be allowed. When entry into the interior is approved, nesting colonies must be avoided whenever possible. The lagoon at Laysan Island is off-limits from May through August, except when visits are specifically authorized by the Refuge Manager.

## KURE ATOLL (STATE OF HAWAII)

Since Kure Atoll is not part of the HINWR but is part of the state of Hawaii Wildlife Refuge, entry clearance by the Department of Land and Natural Resources is required. Requests for permits detailing the proposed study plan should be addressed to:

Ron Walker, Wildlife Branch Chief
Department of Land and Natural Resources
Division of Fish and Game
1151 Punchbowl Street
Honolulu, Hawaii 96813
(808) 548-5917

Permits can only be obtained for educational or scientific purposes of a nature that will not be disturbing to the wildlife occupying the island.

## MIDWAY ISLANDS (U.S. NAVY)

Midway Islands are possessions of the United States administered under the jurisdiction of the U.S. Navy. In order for civilians not connected with the Department of Defense to enter Midway Islands, the following procedures must be followed in accordance with Navy policy.

## Letters of intent

In order to enter Midway Islands, letters of intent must be submitted to three separate offices of the Department of the Navy. These letters may be identical and should contain the following information:

1. Identification of the research project, including purpose, sponsoring agency, and reasons why entrance to Midway is necessary

2. Identity of persons involved in research project by name, social security number, and citizenship. Note: Normally only U.S. citizens are allowed on Midway. If personnel are not U.S. citizens, note this in the letters of intent so that special clearance procedures can be initiated.

3. Duration of intended stay and billeting requests (number of people and number of nights)

4. Date of proposed departure for and return from Midway

5. Method of transportation to and from Midway (Military Airlift Command, ship, or Coast Guard)

Letters of intent should be sent to the following three agencies:

Commander, 3rd Fleet, U.S.N.
F.P.O.
San Francisco, California 96610
ATTN: Travel Clearance Section

Since Midway is a defense installation, security clearance is required by the Secretary of the Navy. Upon receipt of the letter of intent the Travel Clearance Section will issue a security clearance form to be filled out and returned. It is possible to send a photocopy of a completed security form with the letter of intent. This will speed up the procedure considerably. In order to avoid unnecessary delays, fill in all of the spaces on the security clearance forms.

Commander, U.S. Naval Base
Box 110
Pearl Harbor, Hawaii 96860
ATTN: Military Airlift Command

Since the primary means of transportation to and from Midway is by Military Airlift Command (MAC), concurrence for space available on the requested flights is necessary from the Commander at Pearl Harbor. (For information on the specifics of MAC flights, see section on air transportation.)

Commander, Midway Naval Station
F.P.O.
San Francisco, California 96614

The Commander at Midway must give his concurrence for all visiting civilians to gain access to the islands. Also, since billeting space is limited on Midway (and will become more limited with the station's change of classification to an unaccompanied duty station in the summer of 1978), space available for visiting research personnel must be cleared through the Commander.

Since all clearances must be conducted by mail, it is advisable to begin travel clearance arrangements approximately four weeks prior to the anticipated departure date.

When all clearances are completed, the Navy will issue, to each person scheduled to go to Midway, the following items:

1. A Defense Area Entry Authorization Card

2. Travel Authorization Orders for Military Airlift Command

3. MAC Transportation Authorization Papers, which must be presented at the MAC airport terminal upon boarding the aircraft

## KURE ATOLL AND FRENCH FRIGATE SHOALS (U.S. COAST GUARD)

At the present time no written authorization is requested by the U.S. Coast Guard to enter their installations on Kure Atoll and French Frigate Shoals. However, arrangements must be made by telephone with the Aids to Navigation Division, 14th Coast Guard District to stay at the facilities on these islands (see section on surface support facilities).

# TRANSPORTATION TO THE NORTHWESTERN HAWAIIAN ISLANDS

Due to their closure to the public by refuge status, isolated location, and limited runway facilities, the NWHI are not accessible by commercial air carriers. Only three of the islands--Midway, Kure, and French Frigate Shoals--have runways and, except in emergency situations, these facilities are used only by military aircraft for the purpose of servicing the military installations on these islands. Midway is also used as a refueling stop for military aircraft enroute to the Orient or flying fishery patrols.

However, the military does make flights available to personnel with approved research projects in the NWHI. The following is a description of the information and procedures needed to utilize military aircraft and surface transportation to and from the NWHI.

## U.S. COAST GUARD TRANSPORTATION TO KURE ATOLL AND FRENCH FRIGATE SHOALS

Surface transportation

Until the fall of 1977 the Coast Guard flew weekly supply and fishery observation flights alternately to Kure Atoll and French Frigate Shoals each week. However, since that time the Coast Guard has ceased flying patrol and supply flights to French Frigate Shoals due to the dense resident sooty tern populations which are potentially hazardous to aircraft during take-off and landing. In 1977 the terns did not leave French Frigate Shoals in October, as is customary, but stayed on Tern Island for the entire year. When this bird situation is a factor, the Coast Guard charters small private airplanes to deliver mail and necessary supplies to the LORAN station on Tern Island. Since space is limited and weight is restricted to 1,000 lbs on these small planes, there is no allowance for transporting research personnel. Therefore, when the Coast Guard is not operating regular patrol flights to French Frigate Shoals the only method to reach the atoll, other than by research vessel, is to travel onboard a Coast Guard Buoy Tender that services the station approximately every 5 weeks. These tenders sail on a variable time schedule and take approximately 3 days to reach French Frigate Shoals from Honolulu. Sailing dates and arrangements for space on these vessels is handled through:

Logistics Office
14th Coast Guard Division
300 Ala Moana Boulevard
Honolulu, Hawaii 96813

Note: The Coast Guard currently plans to de-activate the Tern Island LORAN facility in July of 1979. For this reason there is currently no plans to re-activate the C-130 log flights regardless of the bird situation. After July 1979 there will be no Coast Guard transportation to French Frigate Shoals.

## Air transportation

The Coast Guard flies regular (semimonthly) observation and supply flights to Kure Atoll. Typically, these flights leave Barbers Point Naval Air Station on Wednesday morning and return on Friday afternoon. Space permitting, persons sponsored by an authorized agency may fly to Kure Atoll on these flights free of charge. Reservations for space on board these flights is handled through the Coast Guard Logistics Office (address and telephone number in preceding section). Billeting reservations for personnel planning to stay at the U.S. Coast Guard LORAN station on Kure Atoll are handled through the Aids to Navigation Office (for details see section on surface support facilities). These two offices, Logistics and Aids to Navigation, have very little communication between them, so reservations for flights and billeting should be coordinated by the traveling parties. It is best to confirm billeting space available for the desired time period prior to arranging flight space.

No written request is needed to fly aboard Coast Guard aircraft or to stay at Coast Guard installations, and all arrangements may be made by telephone.

Departure for Kure Atoll is at 0700 hours from the Coast Guard Operations Area at Barbers Point Naval Air Station. Since this area is in a remote corner of the Air Station and sentries are not always familiar with the location, Figure 2 shows how to reach the area from Honolulu. On the morning of departure it is advisable to arrive at the Coast Guard hangar area half an hour before take-off time. Upon arrival notify the pilot or loadmaster to confirm space available.

The patrol aircraft are C-130's (Plate 1). In special circumstances when there are large numbers of passengers, these planes are fitted with up to 40 commercial aircraft type seats which greatly increase the comfort during the relatively long flight. However, under normal conditions, slung web seats are provided for passengers. Cargo space is variable (Plate 2), depending on the amount of cargo the Coast Guard is carrying. Except in unusual circumstances, there is room for personal luggage and all practical research equipment, including diving gear and a small compressor. Room permitting, and with prior arrangements with the Logistics Office, a small boat may be placed in the aft cargo space of the C-130. All cargo items too heavy to hand carry should be packed on pallets so they can be loaded with a forklift. There is no charge for cargo items.

Flight time to Kure Atoll is approximately 5 to 5-1/2 hours. With weather permitting, most flight patterns are low-level (1,000 to 2,500 ft) patrols for foreign fishing vessels. Passengers are permitted on the flight deck except during take-off, landing, and instrument checks. Since windows in the aft cargo-passenger area of the C-130 are very small and few in number, islands can only be viewed from the flight deck. Flight crews are usually more than willing to position the aircraft for photographing any visible islands.

Ear plugs are recommended, as these aircraft are relatively noisy. Box lunches are available at a cost of $.90.

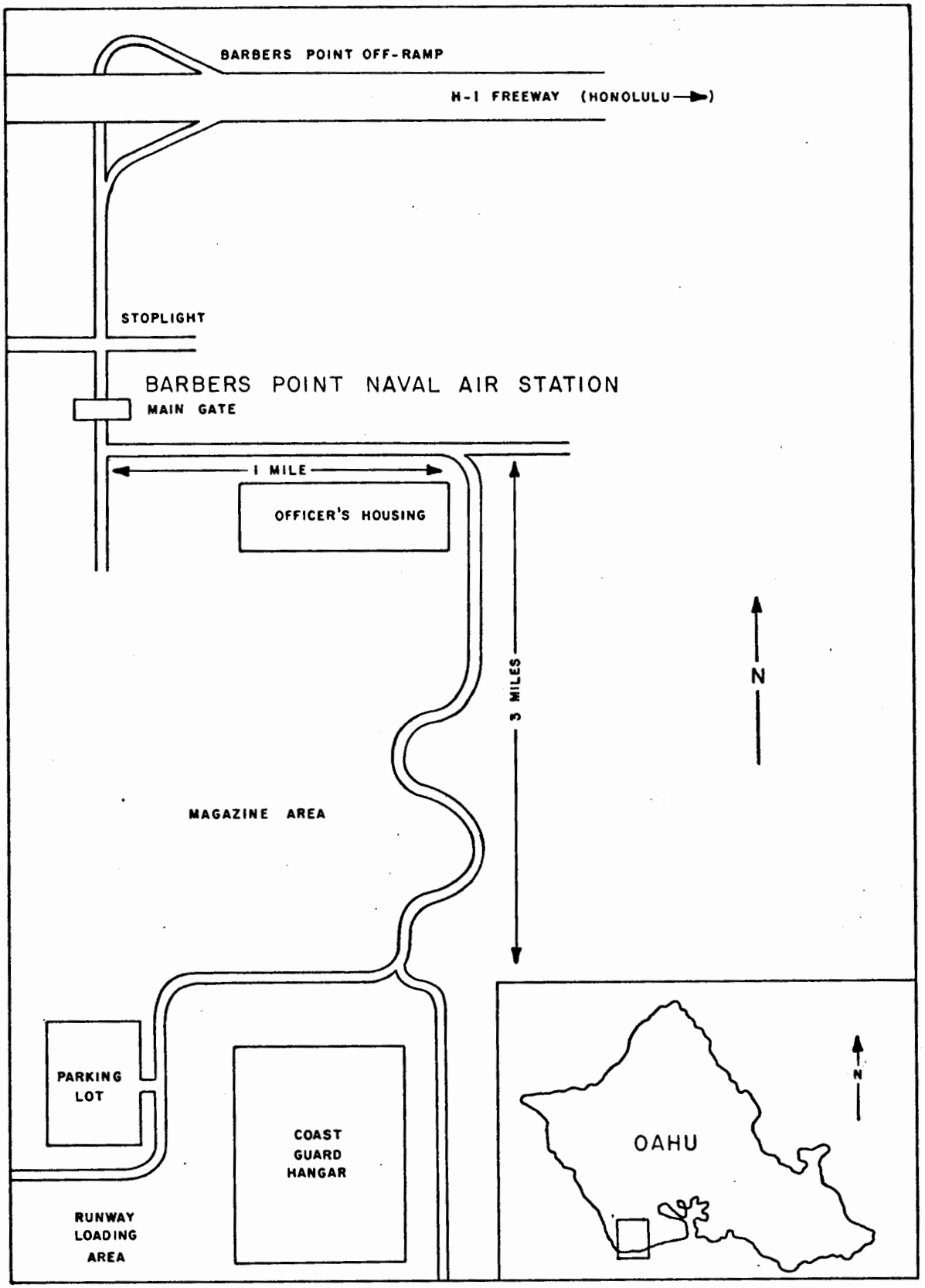



Figure 2. Map showing route to Coast Guard aircraft terminal at Barbers Point Naval Air Station, departure and return point for Kure Atoll

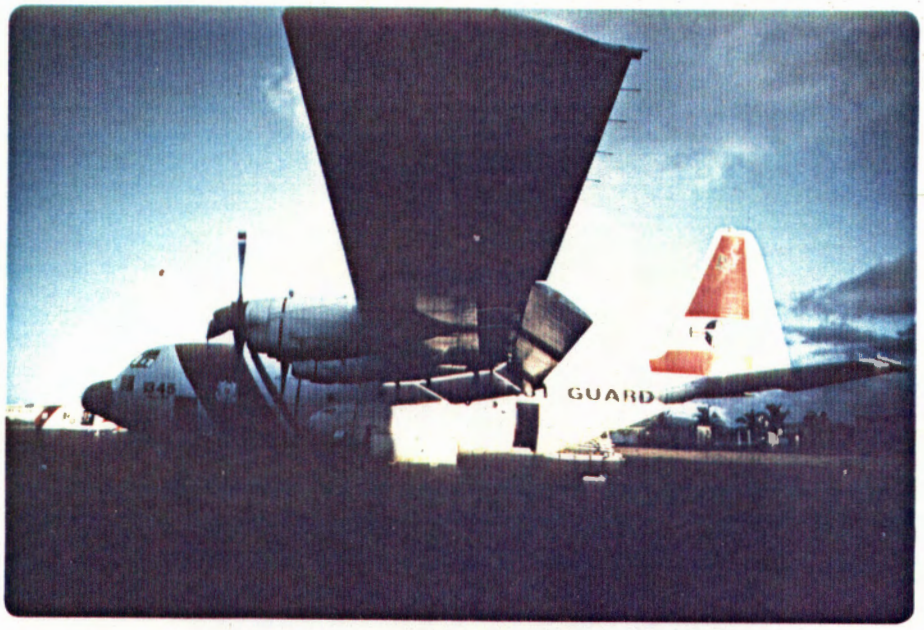



Plate 1. Coast Guard C-130

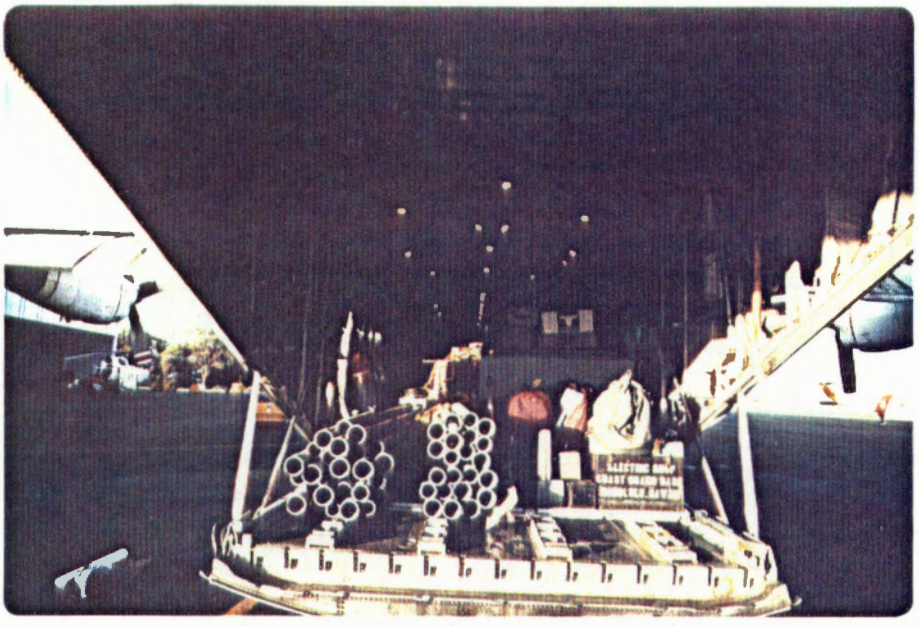


Plate 2. Cargo space in C-130

Vehicles may be left in the barracks parking area adjacent to the hangar area. However, unless the duration of the trip is very short, it is advisable to arrange to be dropped off and picked up at Barbers Point.

The primary purpose of the Coast Guard is marine search and rescue (SAR) operations. Any research activity, no matter how important to the researchers involved, is secondary. Often patrol and cargo flights are cancelled or diverted from their original routes for SAR operations. Therefore, it is necessary to keep all schedules as flexible as possible and to avoid making firm commitments on dates soon after a scheduled return. It is also advisable to pack enough clothes, etc., for an extended stay. Many times a flight to Kure Atoll is cancelled, delaying the return flight to Honolulu for 14 days.

Since the Coast Guard is the only source of air transportation from Honolulu to Kure Atoll and since routine helicopter flights from Midway Islands to Kure Atoll has ceased since April of 1978, research trips should be planned in one increment of 16 days followed by increments of 14 days.

## U.S. COAST GUARD AIR TRANSPORTATION TO MIDWAY ISLANDS

It is also possible to fly to Midway Islands with the Coast Guard. The semimonthly patrol and supply flights bound for Kure Atoll (described above) stop at Midway Islands at some point during the patrol. If arrangements have been made with the Navy (see section on permits and clearances), research personnel may disembark and remain on Midway Islands. The reverse procedure is also possible--to fly from Midway Islands to Honolulu aboard Coast Guard aircraft.

These procedures have the advantage of being free, but the disadvantage of being fairly undependable and infrequent. Coast Guard flights are scheduled twice a month compared with three scheduled MAC flights a week. All arrangements to fly to or from Midway Islands with the Coast Guard are handled through the Logistics Office.

## U.S. NAVY MILITARY AIRLIFT COMMAND (MAC) FLIGHTS TO MIDWAY ISLANDS

Military Airlift Command (MAC) C-141 aircraft regularly fly roundtrip from Honolulu to Midway Islands every Tuesday, Thursday, and Saturday. Clearance to fly to Midway Islands via MAC for civilians is granted by the Commander, Pearl Harbor Naval Base (see section on permits and clearances). Cost of MAC travel to Midway Islands is $124 roundtrip (common user fare) or $212 roundtrip (international tariff fare). In the past all research personnel traveling to Midway Islands have been charged the less expensive fare. Travel Authorization Orders will designate the fare. Checks should be made out to the Accounting and Finance Office, Hickam AFB. To avoid complications and to keep matters with the Navy as simple as possible,

it is advised to have two checks on hand, one for each way, rather than for one roundtrip fare.

Baggage allowance aboard MAC is 66 pounds.

Departure times vary throughout the year. It is best to call MAC Terminal Information at 449-1752 or 449-1753 several days prior to the departure date to confirm the exact time. It is necessary to check in at the MAC terminal, Hickam AFB, 30 minutes prior to departure so that all arrangements can be confirmed. Be sure to have a check for the amount of the one-way fare on hand at check-in. Purchase orders will not suffice. Also, when checking in at the Navy ATCO desk at the MAC terminal, be sure to have on hand the Defense Area Entry Authorization Card, Travel Authorization Orders, and the MAC Transportation Authorization. The last item serves as a boarding pass on all MAC flights.

MAC authorities in Honolulu will not make reservations for the return leg (from Midway Islands to Honolulu). This must be done at the MAC office in the Operations Hangar at Midway Islands. It is best to take care of these return arrangements as soon as possible, as the aircraft can only carry 30 passengers and are often booked. MAC, however, will not book reservations from Midway Islands for more than two weeks in advance. Be sure to have a check for the amount of the one-way fare on hand at check-in.

Figure 3 shows the route to the MAC terminal. It is best not to plan to leave cars on base, unless the trip is to be very short, since cars without military stickers are subject to being towed away after 24 hours. Persons picking up travelers should confirm the time of the return flight by calling MAC Terminal Information (449-1752).

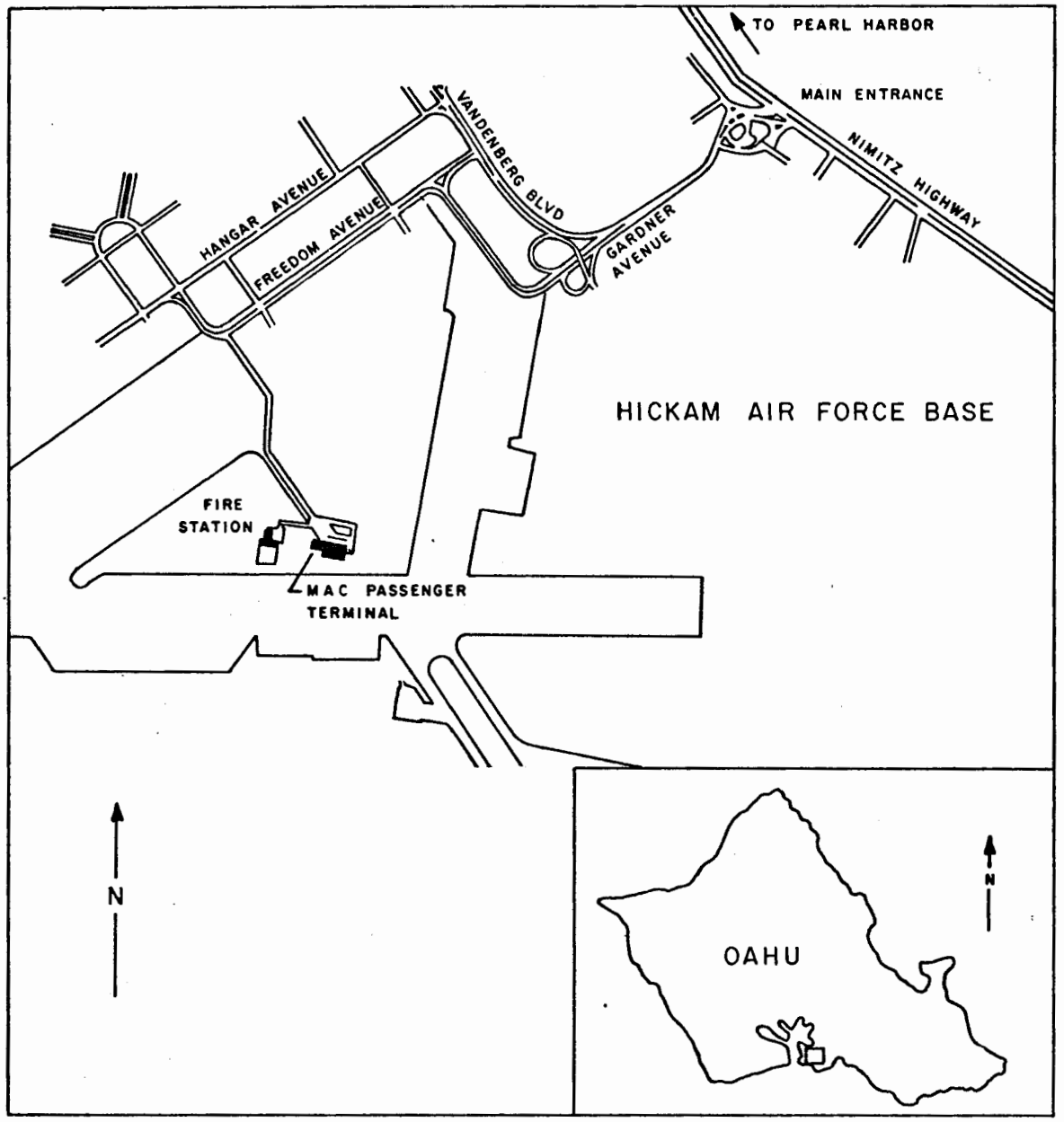



Figure 3. Map of Hickam Air Force Base showing route to MAC passenger terminal.

# RESEARCH VESSELS

At the present time only four ships based in Hawaii are capable of conducting scientific research in the waters of the entire Hawaiian Archipelago. These ships are: (1) the TOWNSEND CROMWELL, operated by the U.S. Department of Commerce, National Ocean Survey; (2) the EASY RIDER, a privately owned commercial fishing/scientific charter vessel; (3) the KANA KEOKI; and (4) the MOANA WAVE. The latter two are oceanographic research vessels operated by the Hawaii Institute of Geophysics, University of Hawaii. The third University research vessel, the NOI'I has a very limited range of 800 km and is used only for one-day research cruises. According to the Scientific Coordinator of Marine Operations, the NOI'I is not capable of any work in the NWHI. Likewise, the VALIANT MAID, a fishing vessel that has previously been used for University charter work, is not capable of extended cruises in the unprotected waters of the NWHI.

Currently, the TOWNSEND CROMWELL and the EASY RIDER are scheduled to participate in the proposed Sea Grant NWHI Fisheries Investigations Program. The National Marine Fisheries Service is donating 30 days per year of shiptime for the productivity and offshore fishery resource assessment projects. The State Office of the Marine Affairs Coordinator is providing funds to charter the EASY RIDER for 30 days per year for the nearshore fishery projects. The EASY RIDER is tentatively scheduled for two 15-day cruises, the first in October of 1978 and the second in May of 1979. The STAR II submersible and her support vessel, the HOLOKAI, and the Launch, Recovery and Transport (LRT) vehicle are also tentatively scheduled for cruises in 1978-79 for 10 survey dives off of Midway Islands, Kure Atoll, and possibly several seamounts 80 km northeast of Kure Atoll. These research dives will investigate precious coral and other shelf/slope resources and habitats of the NWHI. This shiptime is projected with funding provided by the State Marine Affairs Coordinator's Office.

A detailed description of the vessels that may be involved in the NWHI Fisheries Investigations Program follows.

## TOWNSEND CROMWELL

The TOWNSEND CROMWELL (Figure 4 and Plates 3 and 4), a member of the U.S. Department of Commerce Scientific Research Fleet, is designed and outfitted to perform all types of oceanographic and fisheries work in almost any weather or climatic conditions. The CROMWELL was designed by George C. Nickum & Sons of Seattle, Washington and was built by the McDermott Company of Morgan City, Louisiana. The keel was laid on April 15, 1963 and launched on July 27, 1963. Total cost of the vessel was $1.7 million. Honolulu is the home port of the CROMWELL where the vessel is assigned to the Honolulu Laboratory of the National Marine Fisheries Service. For information regarding the TOWNSEND CROMWELL, contact Tom Hida of NMFS at 533-4110 (Kewalo Basin) or 946-2181 (Dole Street Lab).

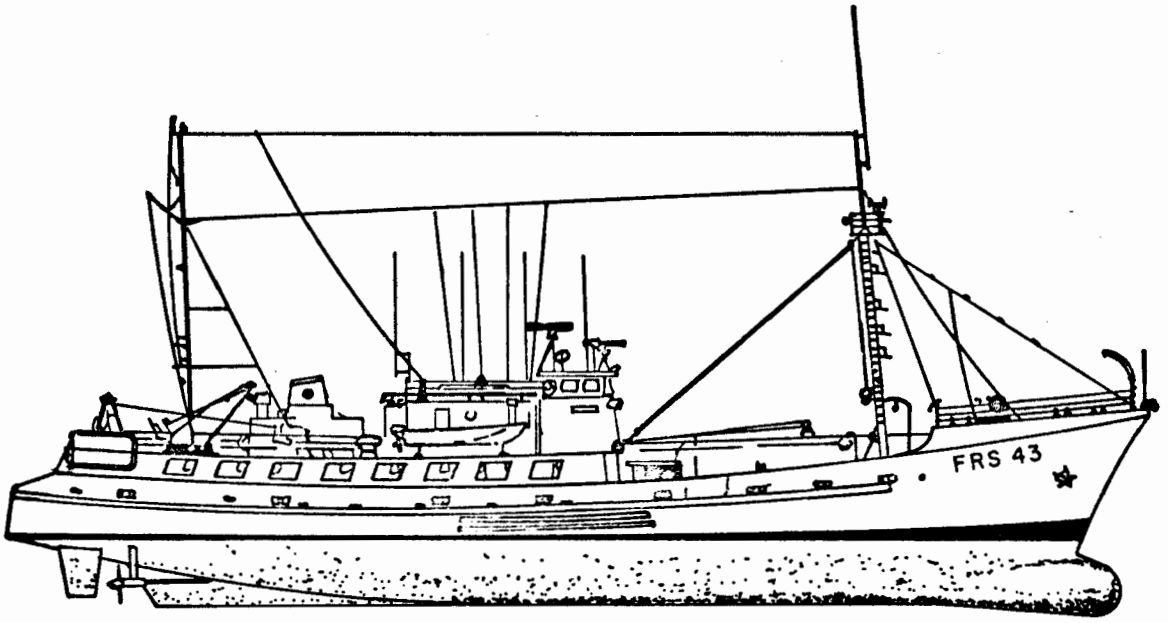



Figure 4. NOAA ship, TOWNSEND CROMWELL

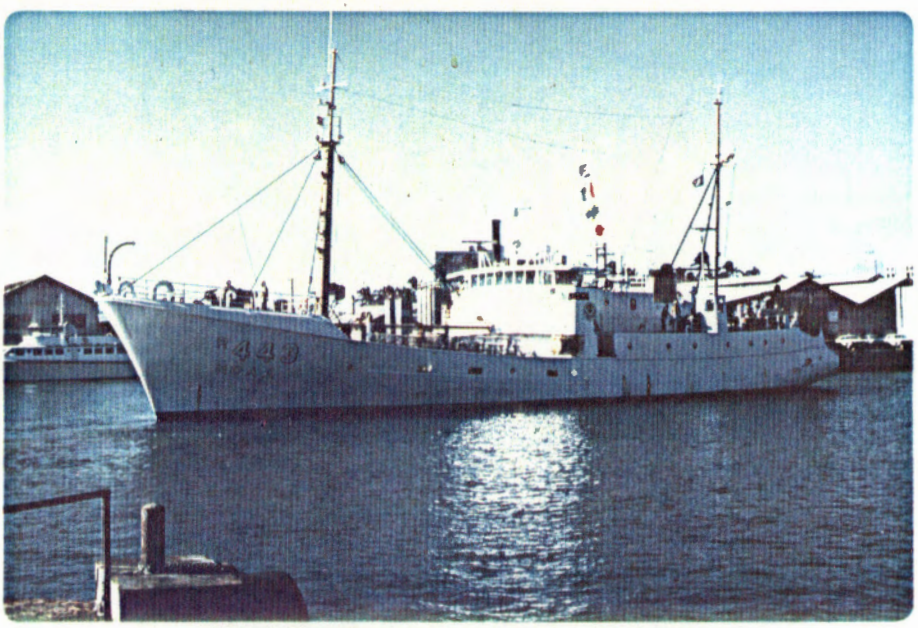


Plate 3. TOWNSEND CROMWELL, port bow view

Plate 4. TOWNSEND CROMWELL, starboard aft view

A list of the TOWNSEND CROMWELL's specifications is given below:

## Ship characteristics

| | |
|---|---|
| Length | 49.7 m |
| Beam | 10.0 m |
| Draft (max.) | 3.6 m |
| Draft (mean) | 2.7 m |
| Displacement tonnage | 652 tons |
| Gross tonnage | 564 tons |
| Net tonnage | 384 tons |
| Hull | welded steel |
| Cruising speed | 11.5 knots |
| Range | 15,000 km |
| Shaft horsepower | 400-400 |
| Fuel | #2 diesel |
| Fuel capacity | 42,000 gallons |
| Fuel consumption | 50 gallons per hour cruising speed |
| Endurance | 33 days |
| Endurance constraint | fuel |

## Habitability

This unit of the NOAA fleet is manned by a crew of 17: a captain, executive, 2nd and 3rd officers, a chief engineer and two assistants, a radioman, seven fishermen, a cook, and a cook's helper. There are accommodations for 9 scientists and provisions for women scientists.

Berthing: 4 one-bunk staterooms
11 two-bunk staterooms

Messing: General mess, 22 persons per seating
Mess charges, $4.50 per day

Laundry: Washer-dryer

Medical facilities: No sick bay
First-aid capability only

## Scientific capability

The TOWNSEND CROMWELL is designed and outfitted for fisheries research and is adapted to several fishing techniques including midwater and bottom trawling, pole and line fishing, longline operations, trapping, handlining, and purse seining. Scientific equipment normally on board is limited to that which supports and is related to these types of operations. There are three scientific working spaces comprising of biological, chemical, and hydrographic laboratories. These labs are equipped with sinks, storage, and counter space and have an area of 27 sq m. Adjacent to the laboratories are three top-opening freezers, each with approximately 2 cu m capacity. Special scientific installations include underwater

observation ports in the bow and two 23 cu m live bait holding tanks with constantly circulating seawater.

Hydrographic instrumentation includes 14 Nansen bottles, CDT, and XBT with digital readout in the electronics lab.

The following gear is used for scientific work onboard the TOWNSEND CROMWELL.

DECK MACHINERY

Winches

Electric drive New England trawler
Line pull: 14,000 ft lbs
Max. pull rate: .45 m per second
Drum capy: 836 m, 3/16" diameter wire
Location: foredeck

Hydraulic Markey winch
Line pull: 2,750 ft lbs
Max. pull rate: 1.22 m per second
Drum capy: 9,144 m, 3/16" diameter wire
Location: portside boat deck

2 Rowe machine hydraulic winches
Drum capy: 1,097 m, 5/8" diameter wire
Location: boat deck

2 Electric hydraulic handline gerdies
Location: starboard foredeck

Power driven fish pot hauler
Location: starboard foredeck

Cranes

Husky Mariner articulated boom
Rotation: 360°
Radius max.: 7.6 m
Radius min.: 1.8 m
Hoisting capy: 2,000 lbs
Location: aft deck

Rowe machine non-telescoping boom
Rotation: 120°
Radius max.: 9.1 m
Radius min.: 3.0 m
Hoisting capy: 10,000 lbs
Location: cargo deck

## ELECTRONICS

### Navigational aids

2 Decca radar
SatNav.
2 Benmar LORAN-A/C
Navidyne OMEGA

### Acoustic aids

2 Raytheon shallow water echo sounders - 21 kHz
Edo deep water echo sounder - 12 kHz
Simrad fish finder
Furuno fish finder
Strazo steerable sonar

### Communications

2 Motorola VHF/FM bridge to bridge transceivers - 25 W power output
2 Sunair HF radiotelephone transceivers
CAI HF radiotelephone transceiver
4 Narco marine VHF emergency capability Emergency Position Indicating Radiobeacon (EPIRB) - 75 mW power output

## ENGINEERING

Main propulsion: Geared diesel

Main engines
Quantity: 2
Type: Diesel
Shaft horsepower: 400-400
Top speed: 12-1/2 knots
Cruising speed: 10-1/2 knots

Reduction gear
Quantity: 2
Manufacturer: Lufkin
Ratio: 2:1

Propellers
Quantity: 2
Type: Controllable pitch
Number of blades: 3
Diameter: 1.67 m

Auxiliary engines
Quantity: 2
Power output: Drive 2 175 KW generators

Fresh water system - evaporators
Quantity: 2
Max. production: 1,800 gallons per day
Normal production: 750 gallons per day
Normal consumption: 750 gallons per day
Storage capacity: 13,000 gallons

## EASY RIDER

The EASY RIDER (Plates 5 and 6) is a documented all-aluminum commercial fishing/scientific charter vessel built in the United States in 1971. It is owned and operated by the Easy Rider Corporation and has the capability of working anywhere in the NWHI during the months of good weather (April to October). The EASY RIDER is 23.2 m in length and has a beam of 7.24 m and a draft of 1.29 m. The EASY RIDER is fully equipped with fishing gear and safety equipment for commercial fishing, including trapping, long-lining, pole and line, and handlining, and can be rigged for seining and trawling. Skiffs up to 5.48 m can be launched and recovered from the aft deck area, and the vessel contains an air compressor that can fill a 72 cu ft SCUBA tank in 6 minutes. It has a refrigerated cargo capacity of 30 tons and a full complement of electronic navigation, acoustic, and communication equipment. The EASY RIDER has a U.S. Coast Guard licensed crew of six and has sleeping space for six scientists. The vessel is fully stocked with all bedding, towels, and galley equipment.

Charter cost is presently $950 per day plus fuel, but this price is subject to increase. The University of Hawaii Sea Grant College Program has reserved the EASY RIDER for 30 days in 1978-79, to be split between two 15-day cruises. The EASY RIDER is berthed in Kewalo Basin, Honolulu, Hawaii.

For further information regarding the EASY RIDER, contact:

Mr. Gary (Skip) Naftel
Easy Rider Corporation
1050 Koloa Street
Honolulu, Hawaii 96816
(808) 734-0376

Ship characteristics

| | |
|---|---|
| Length | 23.2 m |
| Beam | 7.24 m |
| Draft | 1.29 m |
| Useful load (including fuel) | 81 tons |
| Hull | all aluminum |
| Cruising speed | up to 14 knots |
| Range | 6,600 km |
| Fuel capacity | 10,219 gallons |
| Endurance | approximately 16 days |
| Endurance constraint | fuel |

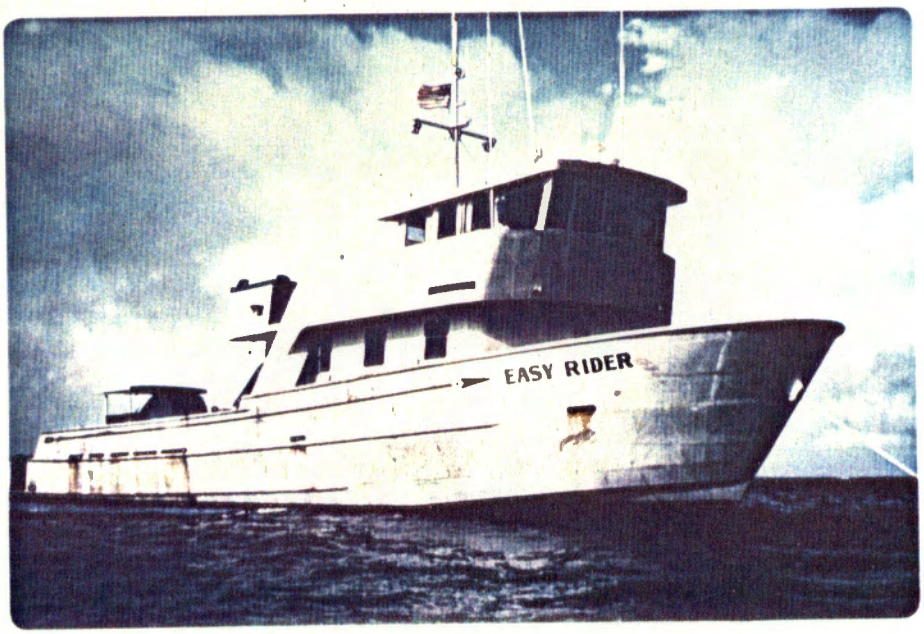



Plate 5. EASY RIDER

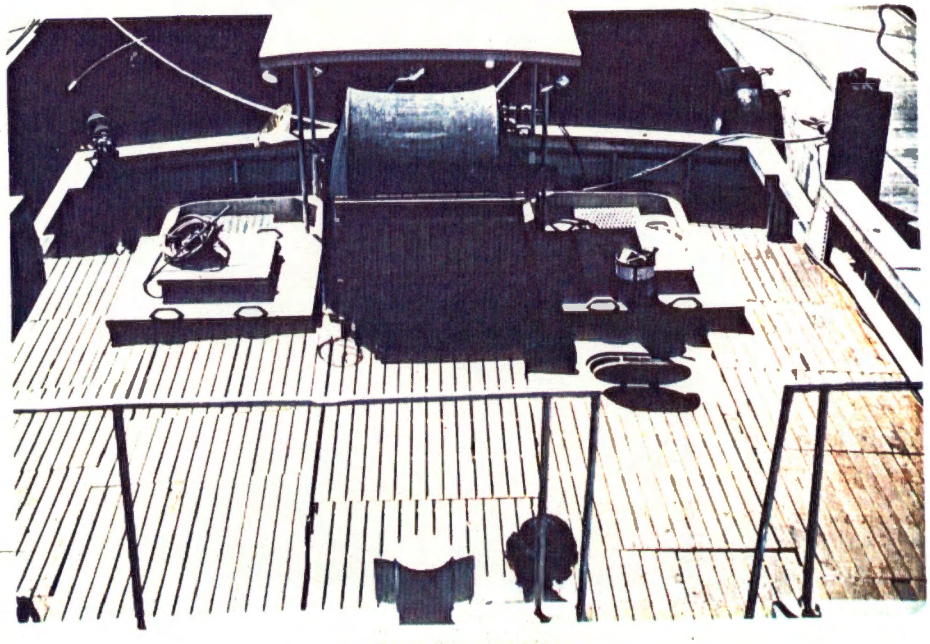


Plate 6. EASY RIDER, aft deck working/storage area

## Habitability

The EASY RIDER is manned by a skipper, engineer, cook, and three deckhands. There are accommodations for six scientists and provisions for women scientists.

Berthing: 3 two-berth staterooms, each with head
1 six-berth stateroom with head

Messing: The EASY RIDER is equipped with a full galley. All meals are prepared by the crew cook and included in the charter cost.

Laundry: Washer-dryer

Medical facilities: First aid capability only

## Scientific capability

The EASY RIDER is designed and outfitted for commercial fishing and as such is capable of being adapted to most fishery research techniques. There is a 12.2 m x 7.28 m clear aft deck for cargo, equipment, or working space. Tanks on the stern may be used to hold live fish or dry cargo. Two 1.5 cu m freezers are available for holding small preserved specimens and there is a 30-ton refrigerated cargo capacity, or 35-ton dry cargo capacity. There is a deckhouse sink, an inside workbench, and ample storage space. All crewmen are certified SCUBA divers who are willing to assist in diving operations. Small boats for inshore work may be launched and hauled out with the stern hydraulic crane.

DECK MACHINERY

HIAB hydraulic crane
Capacity: 2,450 lbs
Reach: 4.4 m
Marco line reel
Izui line puller
Misc. line pullers

ELECTRONICS

Navigational aids

Dynell Omega 300 navigator
Wesmar SS-11 scanning sonar
Decca 101 radar
Benmar A.T.L. 730 digital readout LORAN
Wood Freeman 8321 autopilot

Acoustic aids

Simrad White-Line fathometer

Communications

Sunair B.S.B. 400 S.S.B. radio
Northern S.S.B. Model 70 radio
Konel KS 160 marine radio
Marine Tec V.H.F. marine radio
Konel A.D.F.

ENGINEERING

Propulsion
Twin V-8-71 O.M.C. engines

Power
Twin 30 KW 240 V3 phase 2.71 G.M.C. diesel generators
Electric-driven Vickers hydraulic pump
Hydraulic anchor winch
Wagner hydraulic power steering
Silicon-diode chargers; integrated circuit breakers on all
Circuits and 240V ship-to-shore connection

Mako Model 2100B air compressor

Complete controls on outside maneuvering station

Fresh water system
500 gallons capacity, augmented by AMF Cuno HO 10 evaporator putting out 20 gallons per hour.

## KANA KEOKI

The R/V KANA KEOKI (Plate 7) is a documented research vessel owned by the University of Hawaii and operated by the Hawaii Institute of Geophysics for oceanographic research. The KANA KEOKI was built in 1967 as an offshore supply boat and converted to her current status as a research vessel in 1970. The KANA KEOKI is 47.5 m in length and 10.9 m in beam, draws 3.3 m of water, and has a displacement of 1,000 tons. She has a maximum range of 29,160 km and an endurance of 42 days. The vessel is operated by a crew of 13 and has accommodations for 16 scientists. Cost of operating the vessel is approximately $3,500 per day, all inclusive. Presently the University of Hawaii Sea Grant College Program does not plan to utilize the KANA KEOKI for the NWHI fisheries investigation. For further up-to-date information on the ship's capability, equipment, operating schedule, location, material condition, and availability, contact:

J. Frisbee Campbell
Scientific Coordinator, Marine Operations
Hawaii Institute of Geophysics
2525 Correa Road
Honolulu, Hawaii 96822
(808) 948-7654

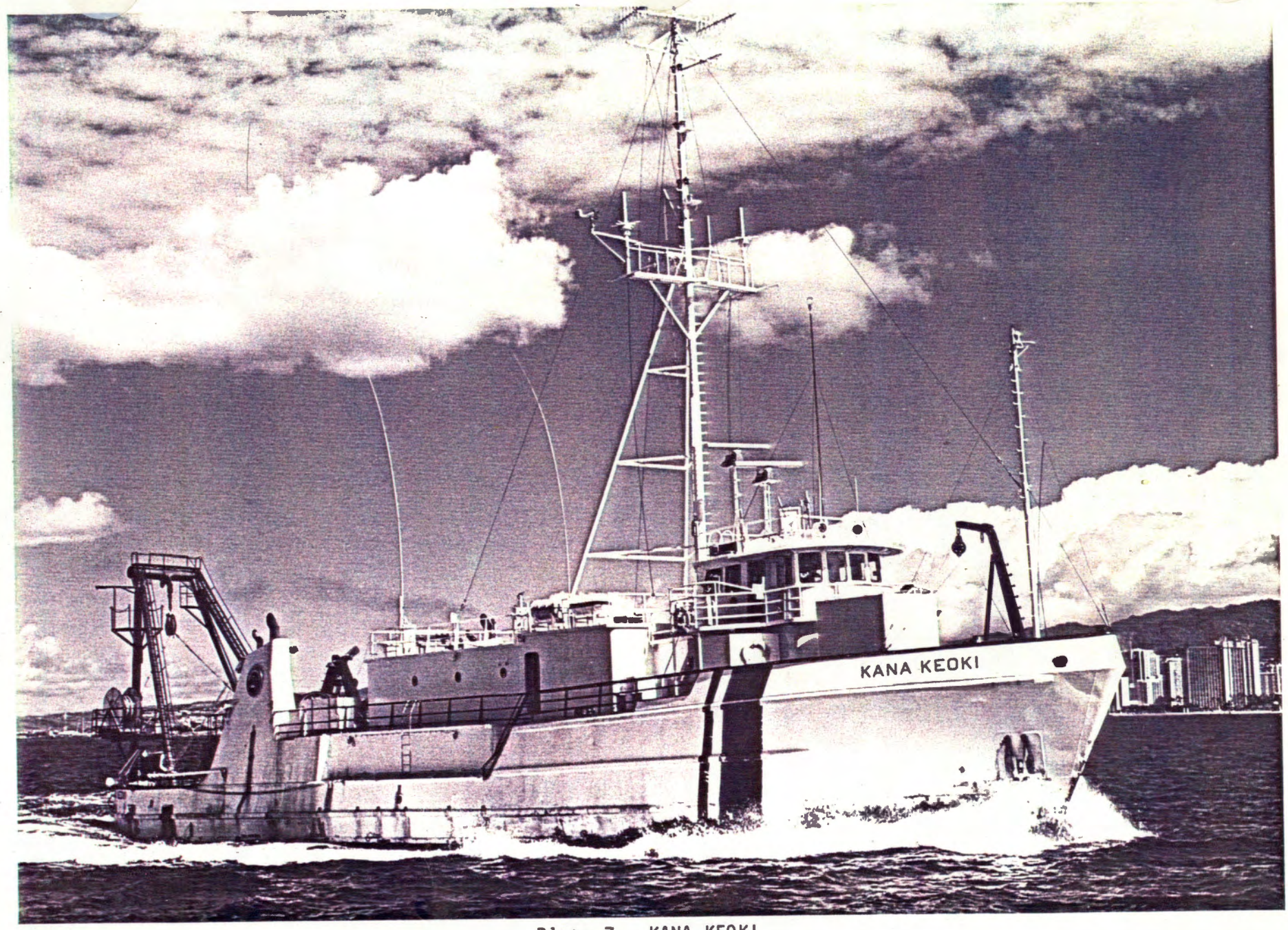



Plate 7. KANA KEOKI

Following is a detailed description of the KANA KEOKI:

## Ship characteristics

| | |
|---|---|
| Length | 47.5 m |
| Beam | 10.9 m |
| Draft (full load) | 3.3 m |
| Freeboard to weather deck | 1 m |
| Displacement (full load) | 1,080 tons |
| Hull | welded steel |
| Cruising speed | 11 knots |
| Maximum speed | 13.5 knots |
| Sustained minimum speed | 1 knot |
| Range at cruise speed | 20,160 km |
| Range at maximum speed | 16,130 km |
| Maximum endurance | 42 days |
| Constraint | refrigerated stores |
| Fuel capacity | 78,907 gallons |
| Shaft horsepower | 900-900 |
| Primary fuel | #1 diesel |

## Habitability

Operating crew: 4 officers, 9 crewmen

Scientific accommodations: 16 berths, including accommodations for women scientists

## Scientific capability

The KANA KEOKI is outfitted for all types of offshore oceanographic research work. There are seven enclosed laboratory spaces comprising an area of 143 sq m. These laboratories operate on separate air conditioning circuits from living and control spaces. There are 322 sq m of open working deck area and equipment can routinely be welded to the working deck. In addition, instrument lab vans can be mounted on the working deck with salt water, fresh water, and ship service air connections. The KANA KEOKI has no center well or underwater observation ports.

DECK MACHINERY

A-frame
- Radius max.: 3 m
- Radius min.: 1 m
- Working capacity max. radius: 60,000 lbs
- Working capacity min. radius: 60,000 lbs

Fixed radius A-frame
- Weight capacity: 60,000 lbs

Hydro boom - radius fixed at 4.5 m
- Location: forward

Telescoping boom
Radius max.: 15.2 m
Radius min.: 1.5 m
Weight capacity max. radius: 1,500 lbs
Weight capacity min. radius: 15,000 lbs

Markey 250 hp winch
Capacity: 13,100 m, 9/16" diameter wire

University of Hawaii constructed winch, 60 hp
Primary wire capacity: 7,620 m, 1/4" diameter wire
Alternate wire capacity: 7,620 m, 1/4" diameter wire
Alternate #2 wire capacity: 10,970 m, 3/16" diameter wire

ELECTRONICS

Navigational aids

Decca Model #RM916 radar, located in wheelhouse
Raytheon RDF Model #DPF 200A, located in wheelhouse
Magnavox SATNAV receiver, located in electronics lab
Chesapeake speed log, located in electronics lab
Analog and digital recorder
Gyro compass, located on bridge
Magnetic compass, located on bridge
Gyro course recorder, located in electronics lab
Autopilot, located on bridge

Acoustic aids

Fathometer, located on bridge
Precision fathometer (3.5 kc), located in electronics lab
Precision fathometer (12.0 kc), located in electronics lab

Data processing equipment

Data General NOVA 1200
Core storage capacity: 12 K link tape auxiliary storage

Communications

2 single sideband radio teletype transmitters and receivers
WWV receiver only
VHF transmitter and receiver

ENGINEERING

Main propulsion: diesel reduction and reverse gear
Propellers: two fixed pitch screws
Shaft horsepower: 900-900

Fresh water system
Potable water capacity: 45,632 gallons
Evaporator capacity: 200 gallons per day

Ship service generators: 4
2 Catepillar 300 KW, 208 volt generators
GMC 30 KW, 115 volt generator
Onan 5 KW, 115 volt generator
Total capacity: 635 KW at any one time
Normal steaming load: 140 KW

Maneuvering propulsion devices
Tunnel thruster: 160 shp, 2,000 lbs thrust located forward

Miscellaneous
Aero Vane, wind speed and direction
Magnetometer
XBT
Stabilizing devices: bilge keels

## MOANA WAVE

The MOANA WAVE (Plate 8) is an undocumented research vessel of the AGOR-22 type built in 1974. It is owned by the U.S. Navy and operated by the Hawaii Institute of Geophysics, University of Hawaii as an oceanographic research vessel. The MOANA WAVE is 53 km in length and 11 m in beam, draws 3.3 m of water, and has a full load displacement of 1,034 tons. The vessel has a cruise range of 12,900 km and an endurance of 30 days. The MOANA WAVE has a full complement of deck machinery, four winches and a boom, navigational aids, data processing equipment, and acoustic gear. At this time, the University of Hawaii Sea Grant College Program does not plan to utilize the MOANA WAVE in the 1978 NWHI fishery investigation study.

For further up-to-date information on the ship's capability, equipment, operating schedule, location, material condition, and availability, contact:

J. Frisbee Campbell
Scientific Coordinator, Marine Operations
Hawaii Institute of Geophysics
2525 Correa Road
Honolulu, Hawaii 96822
(808) 948-7654

Ship characteristics

| | |
|---|---|
| Length | 53 m |
| Beam | 11 m |
| Draft | 3.3 m |
| Freeboard to weather deck | 1.2 m |
| Displacement tonnage | 1,034 tons |
| Hull | welded steel |
| Cruising speed | 10 knots |


Plate 8. MOANA WAVE

| | |
|---|---|
| Maximum speed | 10.7 knots |
| Range at cruise speed | 12,900 km |
| Range at maximum speed | 12,900 km |
| Shaft horsepower | 1,700 |
| Fuel | #2 diesel |
| Fuel capacity | 95,000 gallons |
| Endurance | 30 days |
| Endurance constraint | refrigerated and dry stores |

Habitability

Operating crew: 4 officers, 7 crewmen

Scientific accommodations: 10, including accommodations for 3 women scientists

Note: A van may be secured to the working deck that can provide additional quarters for 8 persons.

Scientific capability

The MOANA WAVE is designed and outfitted for offshore oceanographic research. There is one enclosed lab comprising an area of 19.5 sq m. This lab operates on a separate air conditioning circuit from living and control spaces. There is approximately 324 sq m of open working deck area. In addition, there are provisions for portable vans to be mounted on the working deck. These vans may serve as living quarters for up to 8 persons or as instrument labs, wet labs, and chemical labs. These vans can be fitted with seawater, fresh water, and ship's service air connections. The MOANA WAVE does not have a center well or underwater observation port. Both 400 and 115 volt powers are available for scientific experiments, and the vessel is equipped with a full complement of electronic data processing equipment, navigational aids, and acoustic and communication instrumentation.

DECK MACHINERY

Markey hydro winch
Capacity: 14,000 m, 1/4" diameter primary wire

Northline winch
Capacity: 12,000 m, 1/2" diameter primary wire

Northline Intermediate 250 hp winch
Capacity: 7,000 m, 1/2" diameter primary wire

Electric drive hydro winch
Capacity: 25,000 m, 1/4" diameter primary wire

Telescoping Boom crane
Radius max.: 12.2 m
Radius min.: 8.5 m
Weight capacity, max. radius: 4,500 lbs
Weight capacity, min. radius: 7,000 lbs

## ELECTRONICS

### Navigational aids

Sperry LORAN, located in pilot house
Benmar ADF, located in pilot house
Sperry radar, located in pilot house
Decca radar, located in pilot house
Magnavox Satellite Navigational Receiver
Tracor OMEGA, located in electronics lab
Ocean applied Research ADF, located in pilot house
Sperry Gyro, located in pilot house
Decca Autopilot, located in pilot house
Sagem Speed Log, located in electronics lab

### Acoustic aids

Ross fathometer
Raytheon 3.5 KC precision depth sounder
Raytheon 12 KC precision depth sounder
XBT ($H_2O$ temperature to 7,500 m)

### Communications

Teletype/single side band/AM receiver
VHF/FM, AM/single side band/citizens wave

### Data processing equipment

Hewlett Packard 9830-A
Data General NOVA 600, core storage capacity: general purpose 32 K, data logger 16 K; auxiliary storage on disc and magnetic tape

## ENGINEERING

### Propulsion plant

Main propulsion: Diesel controllable pitch
Shaft horsepower: 1,700
Number of screws: 2
Number of rudders: 2
Primary fuel: #2 diesel
Fuel capacity: 95,000 gallons

### Ship's service generators

Number of generators: 2
Total capacity: 600 KW
Normal steaming load: 100 KW
General description: Caterpiller/Kato, AC current, 400 volts

### Maneuvering propulsion devices

Tunnel thruster, 150 shp, 2 speeds (slow and fast)

Fresh water system
Potable water capacity: 8,600 gallons
Evaporator capacity: 1,500 gallons per day

## STAR II

The STAR II (Figure 5 and Plate 9) is a two-man submersible built in 1966 by the Electric Boat Division, General Dynamics Corporation, Groton, Connecticut. Currently the vessel is owned and operated by the University of Hawaii for research purposes.

Ship characteristics

| | |
|---|---|
| Length | 5.4 m |
| Beam | 1.6 m |
| Height | 2.3 m |
| Draft | 1.5 m |
| Weight (dry) | 5 tons |
| Operating depth | 366 m |
| Collapse depth | 731 m |
| Hatch diameter | .50 m |
| Life support (max.) | 48 man-hours |
| Total power | 14.8 KW hr |
| Speed (knots) cruise | 1/10 hr |
| Speed (knots) max. | 3/1.5 hr |
| Crew | 1 pilot, 1 observer |
| Payload | 250 lbs |
| Pressure hull | Spherical shape, 1.5 m I.D., 5/8" thick HY-60 steel |
| Ballast/buoyancy | Main ballast tank of 500-lb capacity is blown by four tanks of compressed air at 2,250 psi. Auxiliary seawater ballast tank of 130-lb capacity is used to obtain buoyancy adjustments when submerged. Two blocks of suntactic foam are carried fore and aft to provide additional positive buoyancy. |
| Propulsion/control | Main propulsion is provided by two propellers mounted aft on stabilizing fins and driven by a 2-hp DC motor at 900 rpm which is reversible. Immediately behind the hatch is a vertical thruster of similar characteristics as the main propulsion units. Electrically driven rudder controls underway lateral maneuvering. |
| Trim | No systems provided |
| Power source | Main power is derived from externally mounted, pressure-compensated lead-acid batteries providing 180 amp-hr at 115 VDC. |
| Life support | Gaseous $O_2$ is carried within the hull; $CO_2$ is removed by soda sorb. |
| Viewing | Six viewports 13 cm I.D., 23 cm O.D., and 1.5 cm thick. A smaller viewport (5 cm I.D.) is located in the hatch cover. |

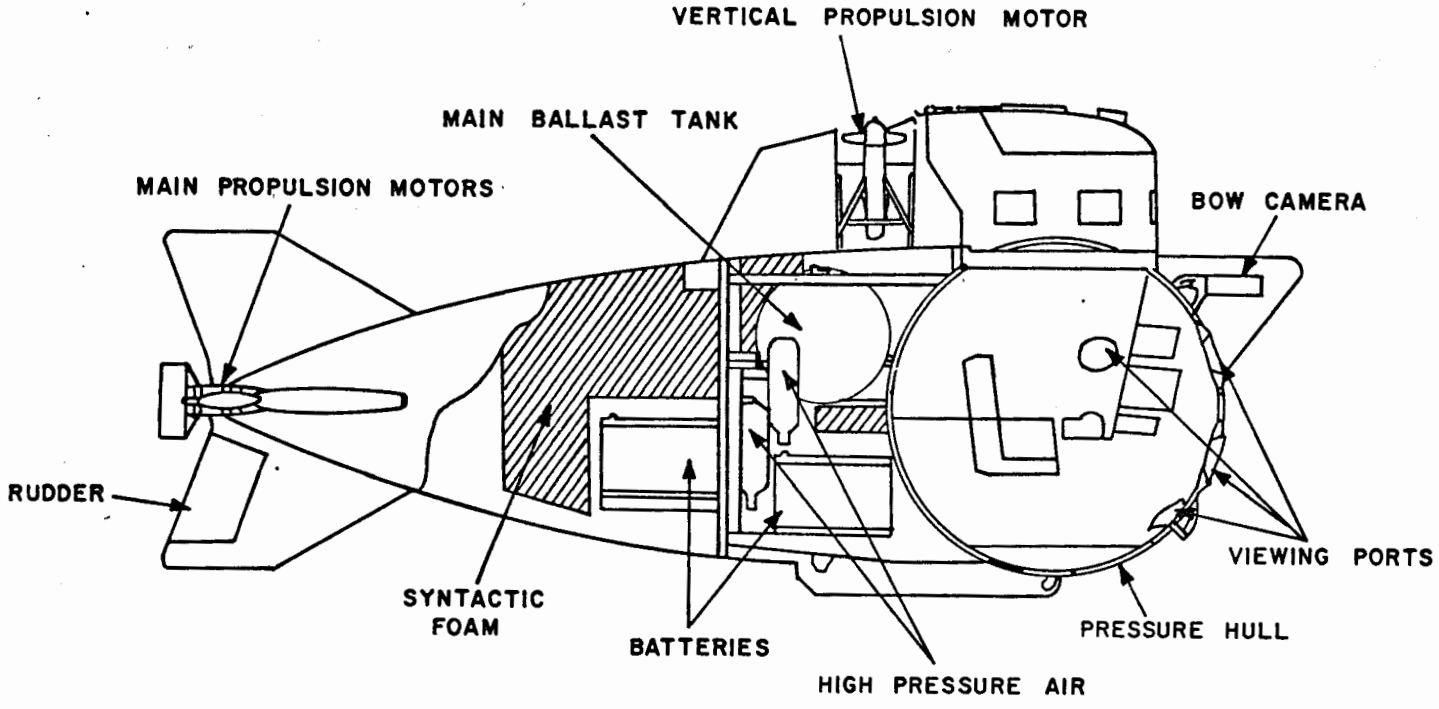



Figure 5. Cutaway diagram of STAR II


Plate 9. STAR II on LRT

| | |
|---|---|
| Operating/scientific equipment | UQC, CB radio, still camera, TV pinger, Magnesyn compass, altitude/depth echo sounder, depth gauge |
| Manipulators | One |
| Safety features | Dropable skid (300 lbs). Emergency battery pack in pressure hull, SCUBA regulator in pressure hull provides emergency breathing by drawing off the deballasting air supply. Hull can be flooded for emergency exit. |
| Surface support | R/V HOLOKAI, LRT |

## R/V HOLOKAI

Ship characteristics (Figures 6 and 7 and Plate 10)

| | |
|---|---|
| Built | 1968 |
| Length | 21 m |
| Beam | 5.8 m |
| Draft | 2.13 m |
| Tonnage | 49 net, 73 gross |
| Complement | 4 crew, 4 scientific party |
| Speed | 10 knots |
| Range | 6,450 km |

Habitability

Accommodations: 6 bunks, located in crew's quarters

Scientific capability

DECK MACHINERY

6-ton hydraulic towing winch
30 FPM, 915 m, 1/2" diameter wire
2 10" diameter gypsies 18 FPM
2 12" diameter gypsies 90 FPM
2-ton double drum anchor windlass
65 FPM, 365 m, 1/2" diameter wire
2 22 cm diameter gypsies

ELECTRONICS

Magnetic compass
Sirius gyro compass
Decca Model RM-314 radar
Bendix Model DR 20A fathometer
Simpson Model T VHF transceiver
Wesmar Model SS210S sonar

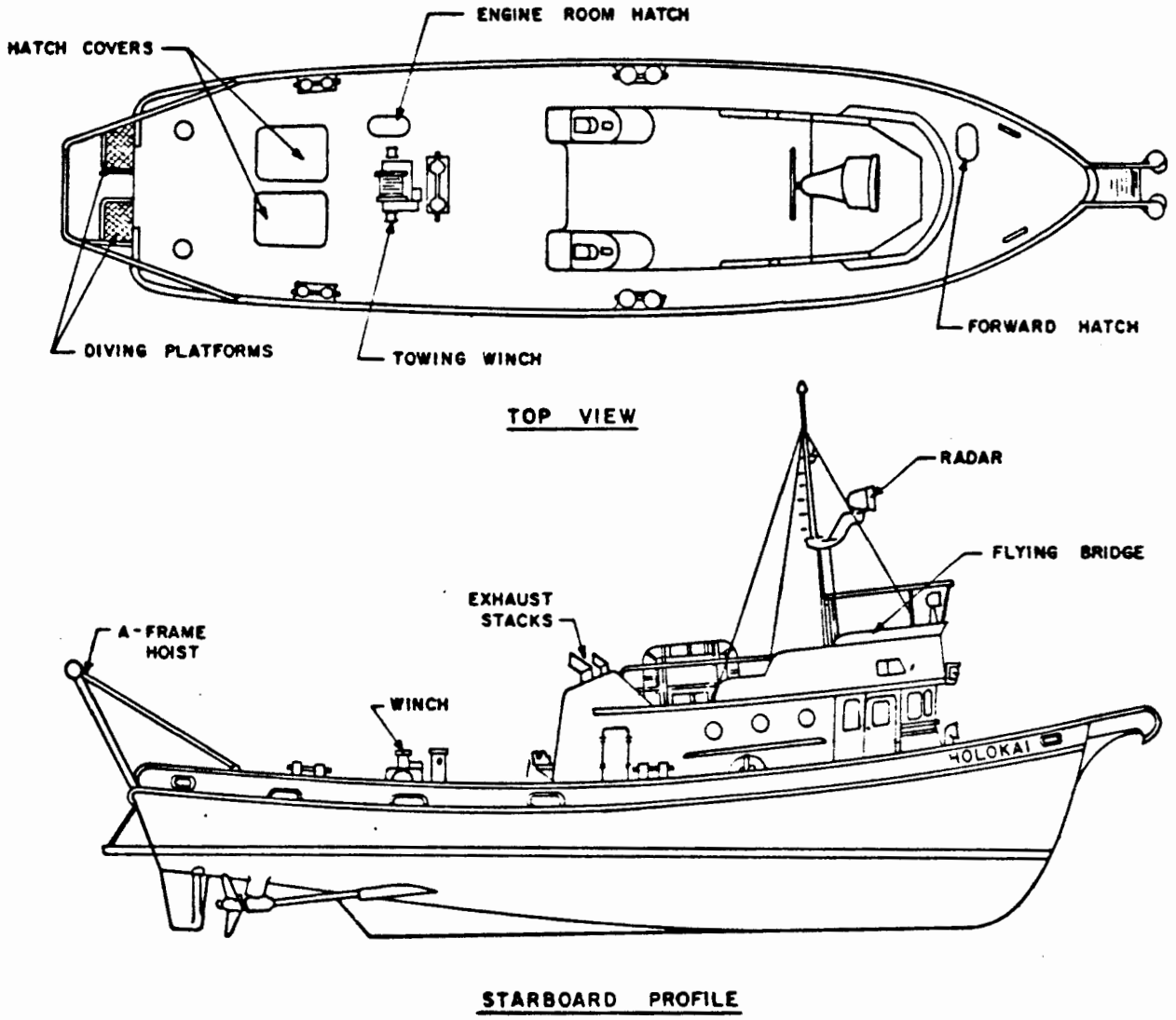
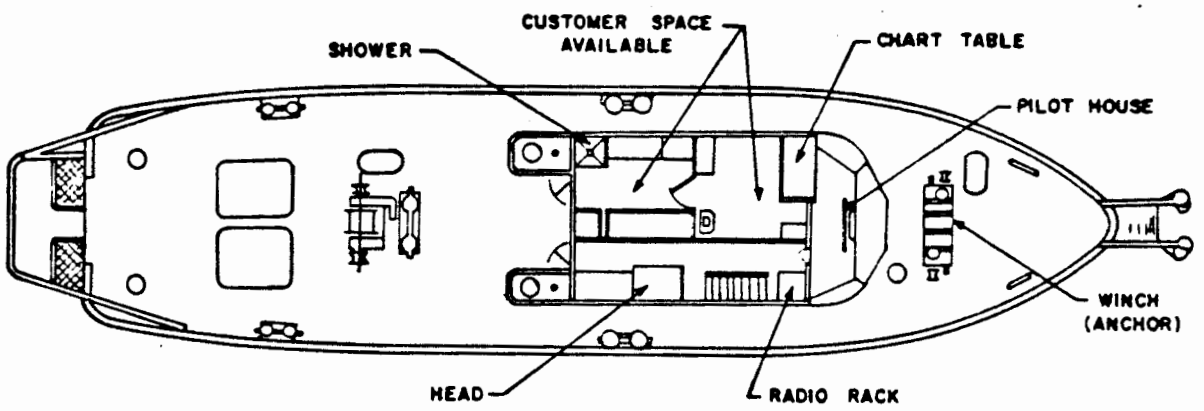
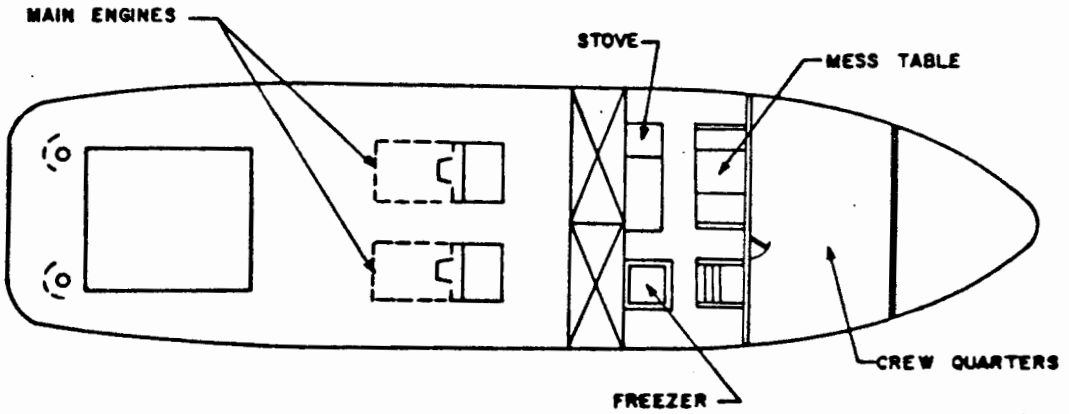



Figure 6. HOLOKAI; top view and starboard profile




MAIN DECK




BELOW DECK

Figure 7. HOLOKAI; main deck and below deck view


Plate 10. HOLOKAI

ENGINEERING

Rix HP air compressor 20 SCFM at 3,000 psi, air storage 2,400 cu ft at 3,000 psi

Curtis LP air compressor 9.1 SCFM

Storage hold: approximately 3 m x 4 m x 2 m H

Space for contractor's equipment: approximately 2.5 m x 3 m x 2 m H

Fresh water capacity: 1,000 gallons

## LAUNCH, RECOVERY AND TRANSPORT VEHICLE - LRT

Ship characteristics

| | |
|---|---|
| Payload | 12,000 lbs |
| Gross weight | 13,500 lbs |
| Construction material | All aluminum |
| Vehicle dimensions | 5 m x 11 m |

# PHYSICAL CHARACTERISTICS OF THE ISLANDS

While the research proposed in the University of Hawaii Sea Grant NWHI Fisheries Investigations Program will be conducted primarily in the waters surrounding the NWHI, rather than on the islands, it is nevertheless important to have a descriptive overview of the emergent lands. A summary of the physical characteristics of all uninhabited islands in the NWHI is presented in this section. A more detailed description of the three inhabited islands, Kure Atoll, Midway Islands, and Tern Island of French Frigate Shoals, as well as descriptions of the surface support facilities for visiting researchers, is presented.

The most comprehensive and detailed source of information on the NWHI is a series on the natural history of the islands published in the *Atoll Research Bulletin*. These works are the result of the Smithsonian sponsored Pacific Ocean Biological Survey Program (POBSP) and include a description of the geology, climate, history, chronology of scientific visits, ecology, and accounts of resident species including vegetation, reptiles, birds, and mammals. A list of the series as well as the author, year, and volume number of each is given below.

"Natural History of French Frigate Shoals," A.B. Amerson, 1971, Vol. 150.
"Natural History of Kure Atoll," P.W. Woodward, 1972, Vol. 164.
"Natural History of Gardner Pinnacles," R.B. Clapp, 1972, Vol. 163.
"Natural History of Laysan Island," C.A. Ely and R.B. Clapp, 1973, Vol. 171.
"Natural History of Pearl and Hermes Atoll," A.B. Amerson, 1974, Vol. 174.
"Natural History of Lisianski Island," R.B. Clapp, 1975, Vol. 186.
"Natural History of Necker Island," R.B. Clapp and E. Kridler, 1977, Vol. 206.
"Natural History of Nihoa Island," R.B. Clapp, E. Kridler, and R.R. Fleet, 1977, Vol. 207.

Presently, the most detailed charts of the NWHI, including reefs and surrounding waters, are the Nautical Charts published by the National Oceanographic and Atmospheric Administration, National Ocean Survey. A list of the charts of the NWHI region including chart identification number and scale, follows (Table 1).

TABLE 1. NOAA NATIONAL OCEAN SURVEY NAUTICAL CHARTS OF THE NWHI

| Chart Number | | Title | Scale |
|---|---|---|---|
| Old System | New System | | |
| 4171 | 19402 | French Frigate Shoals Anchorage | 1:25,000 |
| 4172 | 19401 | French Frigate Shoals | 1:80,000 |
| 4173 | 19421 | Gardner Pinnacles and approaches<br>Gardner Pinnacles | 1:100,000<br>1:20,000 |
| 4174 | 19441 | Maro Reef | 1:80,000 |
| 4175 | 19461 | Pearl and Hermes Reef | 1:40,000 |
| 4177 | 19483 | Kure Island | 1:20,000 |
| 4180 | 19013 | Hawaiian Islands, northern part | 1:675,000 |
| 4181 | 19016 | Nihoa to French Frigate Shoals<br>Necker Island, Nihoa | 1:663,392<br>1:20,000 |
| 4182 | 19019 | French Frigate Shoals to Laysan | 1:653,219 |
| 4183 | 19022 | Laysan to Kure | 1:642,271 |
| 4185 | 19048 | Gambia Shoals to Kure including approaches to Midway | 1:80,000 |
| 4186 | 19442 | Lisianski and Laysan Islands<br>West Coast of Laysan Island | 1:40,000<br>1:10,000 |
| 4188 | 19481 | Midway Islands | 1:32,500 |

The *Marine Atlas of Hawaii: Bays and Harbors*, a University of Hawaii Sea Grant College Program publication edited by J.M. Grace, outlines in capsule form the geography, currents, local magnetic disturbances, anchorages and dangers, banks, and shoals of each of the islands and nearby banks.

The NWHI are part of the Hawaiian chain, an archipelago which rises above an elongated submarine ridge that stretches roughly 3,200 km in a southeast-northwest direction. Constructed of volcanic material that erupted from a zone of fissures on the ocean floor, the Hawaiian chain consists not only of visible islands but also of several submarine peaks and numerous banks. Because of the clear sequence of volcanic island formations from west to east, it is hypothesized that the atolls of the NWHI are vestiges of once high volcanoes that have been worn down by erosional forces coupled with subsidence to form low, sandy atolls. Many of these atolls and islands are surrounded by shallow reefs and banks.

Based on the nature of the islands and the stage of development, the Hawaiian chain may be divided into three parts: the southeastern part which is composed of the eight high volcanic islands or the present major islands; the middle part including Kaula Rock near Niihau, Nihoa Island, Necker Island, French Frigate Shoals, La Perouse Pinnacle, and Gardner Pinnacles; and the northwestern part consisting of low atolls, sandy islets, reefs, and shoals including Laysan Island, Lisianski Island, Pearl and Hermes Atoll, Midway Islands, and Kure Atoll (Uchida, 1977).

## The Uninhabited Islands

### Nihoa Island

Nihoa Island (Figure 8 and Plate 11), also known as Bird Island, is the easternmost of the chain of islands comprising the Hawaiian Islands National Wildlife Refuge. Approximately .75 sq km in extent, it lies at 23°06' N latitude and 161°58' W longitude, about 403 km from Honolulu. Its nearest neighbor is Necker Island, lying about 250 km to the west-northwest.

The island, a remnant of a volcanic cone, is characterized by steep slopes, rocky outcroppings, a well-developed valley, and precipitous cliffs. Looking from the south, the island is saddle-shaped in appearance with the highest peaks being found on the northeastern and northwestern corners of the island. The maximum elevation of 270 m is to the northwest of Millers Peak (see Figure 8). In the vicinity of Millers Peak are several acres of reasonably level land which is utilized by albatrosses for nesting. At the northeastern corner of the island is Tanager Peak (260 m elevation). Between the two peaks, the elevation of the ridge drops to 109 m near the head of Middle Valley. This area often has small nesting concentrations of blue-faced boobies.

Cliffs dominate the perimeter of the island. The north, west, and east cliffs are nearly perpendicular and in places even overhang.

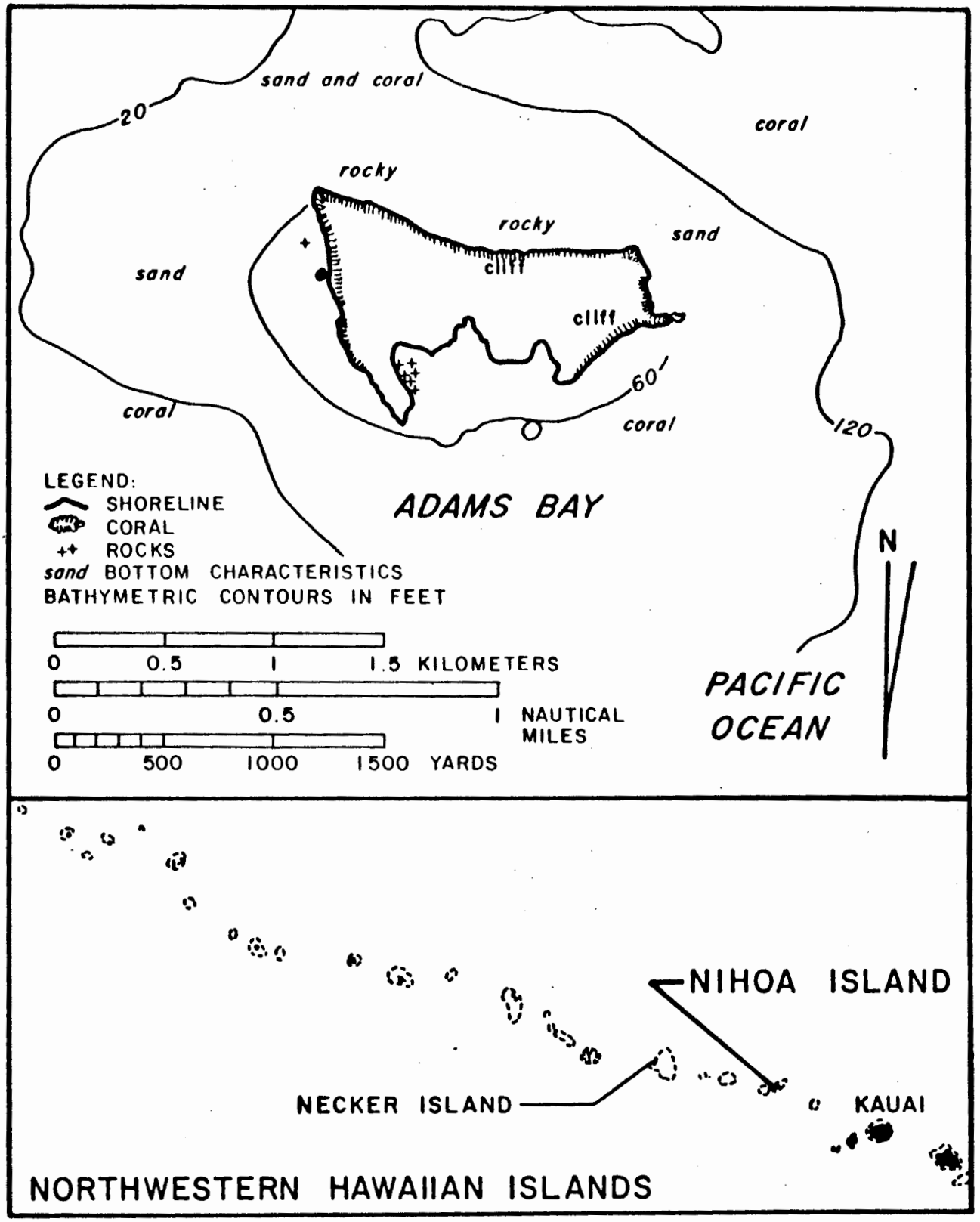



Figure 8. Nihoa Island (from NOAA chart 19016)

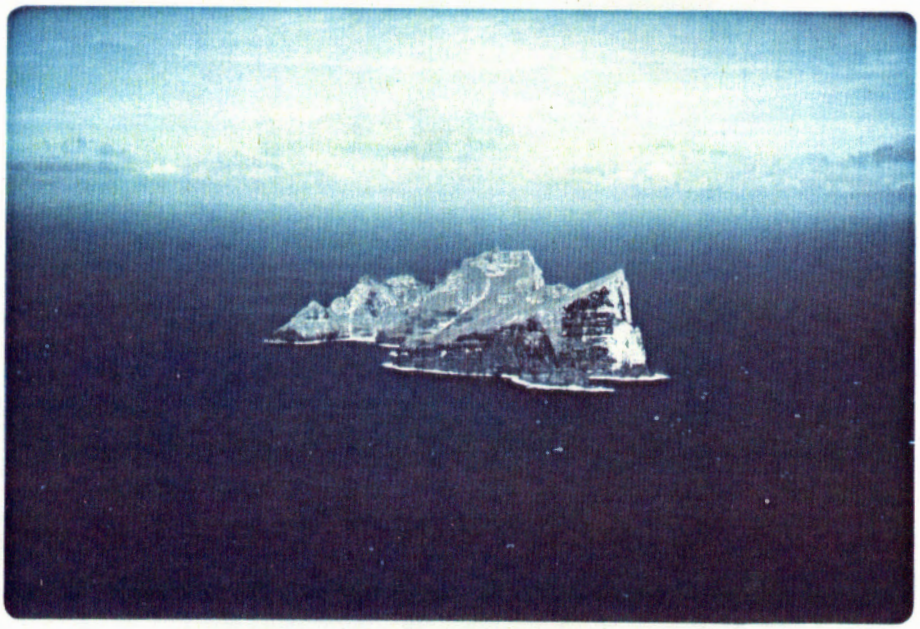


Plate 11. Nihoa Island, aerial view looking north

The cliffs of the south side are only 15 to 30 m high and can be easily scaled. Six valleys, varying considerably in the steepness of the slopes of the bordering ridges, fan out radially to the center or south of Adams Bay.

The irregular southern perimeter of the island enclosing Adams Bay is divided into three coves, the westernmost of which has a small sandy beach called Darby's Landing. It received its name in 1914 when a Lieutenant Darby swam ashore for some rock specimens. This is a poor landing spot because of the presence of submerged rocks.

The coves to the west are edged by rock terraces. The best landing spot is on the eastern side of the middle cove.

The island is covered with vegetation but is occasionally subject to drought which changes its green appearance to yellowish brown. Grasses tend to dominate the ridges and the valleys are covered by dense shrub.

Nihoa Island lies near the southwesterly end of a submarine bank whose depths range from 18 to 38 fathoms (37 to 76 m) and which extends 26 km from Nihoa Island in a northwesterly direction. Another bank at the 15 to 23 fathom (30 to 46 m) depth range lies 33 km west-southwest of Nihoa Island; this bank is about 27 km long and 19 km wide.

The remains of ancient dwellings and terraces used for cultivation are evidence that the island was formerly occupied (McDonald and Abbott, 1970). How the inhabitants obtained water is still unknown, however. Several seeps have been found on the island, the principal one being 41 fathoms (82 m) deep; the water, however, is somewhat brackish and heavily tainted with guano (Clapp et al., 1977).

Low shrubs, seldom above 1 m high, cover the sides and much of the floors of the valleys. Shrubs are sparser and tufts of grasses more common on the ridges. The total number of species of vascular plants known to grow on Nihoa Island is 25. In addition, 27 species of birds have been recorded, 18 of which are seabirds. Two endemic species, the Nihoa finch and Nihoa millerbird, are listed as endangered species. The Hawaiian monk seal and the green sea turtle are both uncommon visitors to Nihoa Island and do not breed there.

## Necker Island

Necker, a small, precipitous, rocky island that lies at 23°35' N latitude and 164°42' W longitude, is located near the eastern end of the Northwestern Hawaiian Islands. Its nearest neighbors in the chain are French Frigate Shoals, lying about 120 km to the west, and Nihoa Island, 250 km to the east-southeast. Necker Island is located approximately 645 km northwest of Honolulu.

Necker is a narrow island less than 1,200 m long and about 150 m wide, with an estimated area of .18 sq km (Figure 9 and Plate 12). The highest point is 84 m above sea level. The island consists of two parts, the principal one is a ridge extending nearly due east and west, 1,230 m long and

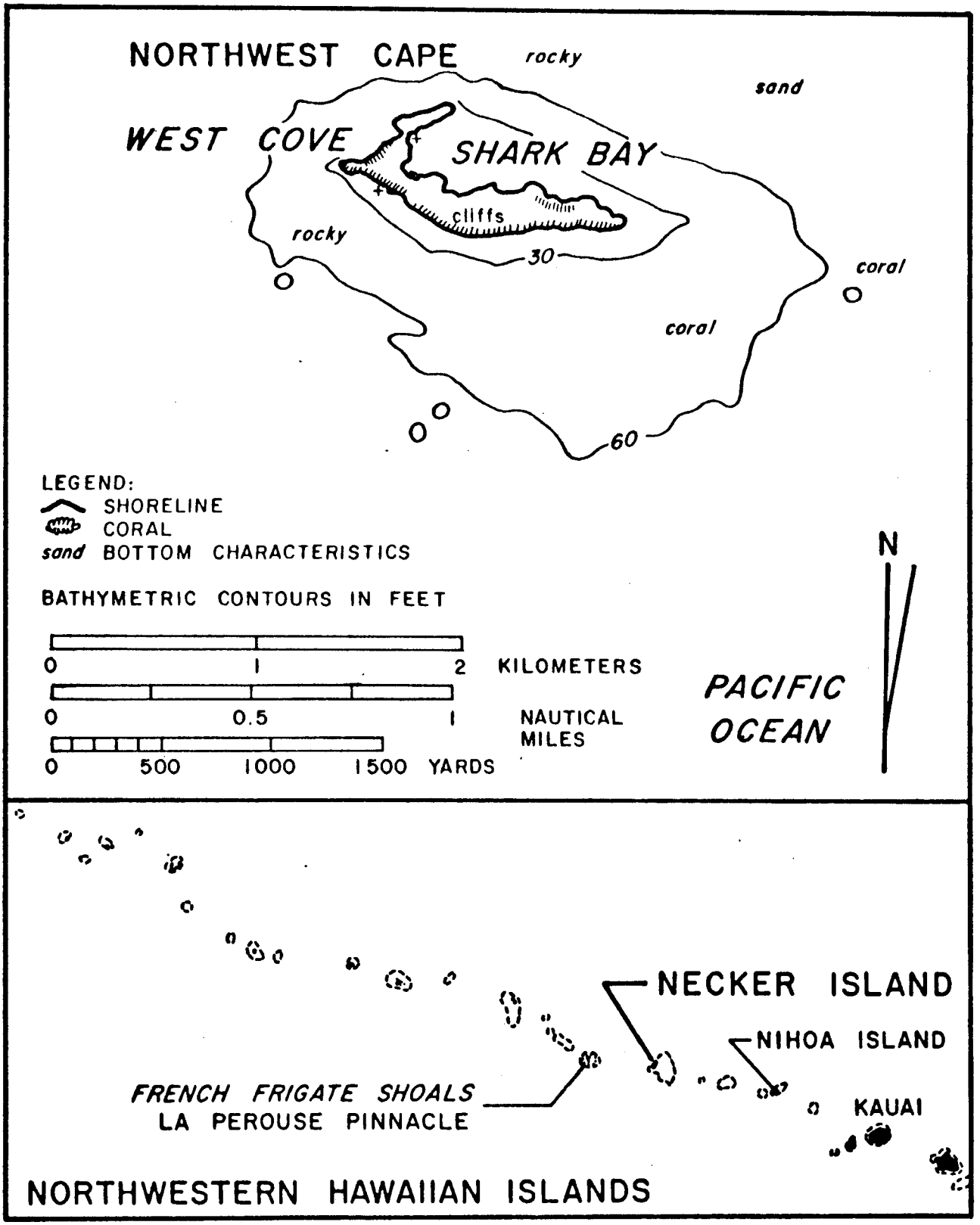



Figure 9. Necker Island (from NOAA chart 19016)

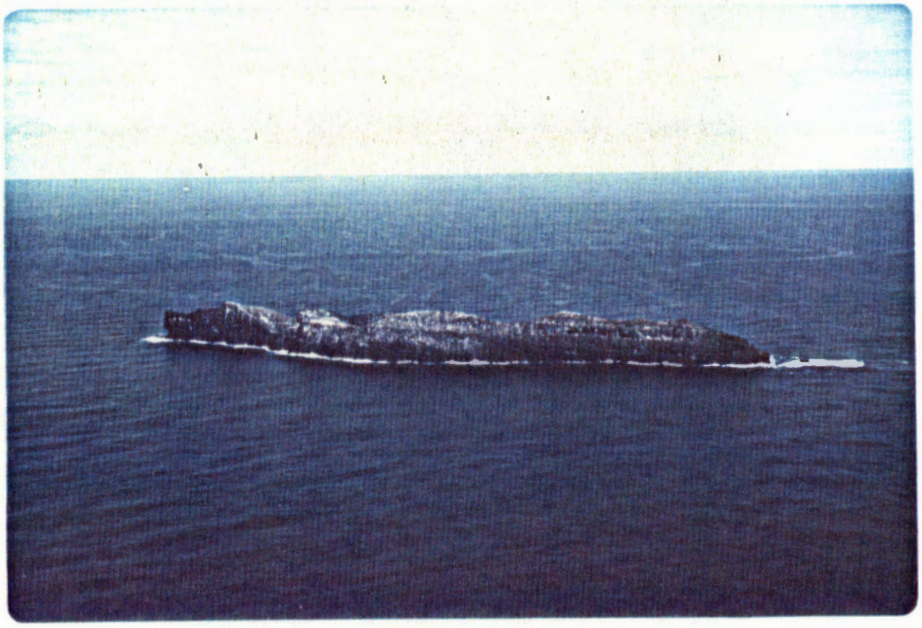


Plate 12. Necker Island, aerial view looking north

varying from 61 to 184 m in width. On this ridge are five peaks separated by shallow saddles. From the westernmost peak a peninsula extends 154 m north-northeast to a gap only a few feet above sea level. Landings are generally made here and are often particularly difficult and dangerous due to large breakers. At the east end of the main part of Necker Island is a low islet about 23 m wide and 61 m long. It is awash at high tide.

Necker Island lies on a shallow, roughly oval platform which measures 61 km long in the northwest to southeast direction and about 32 km wide. The positions of the island and the former volcanic center indicate that the core was not a single shield volcano, but a group of shield volcanoes similar to the island of Hawaii. Necker Island itself is composed of vertical dikes and is an eroded remnant of one of the shield volcanoes.

The steep slopes of the island have little or no vegetation. Along the shallow valleys and on the rounded crests of the hills a few species of plants are well established in the thin soil, however.

Necker Island once had a sizable human population. Remains of fishponds, ditches, agricultural terraces, and house and temple platforms are evidence of the occupation. It has been conjectured that many of the ruins and artifacts appear to have been left by a group of people who preceded the Hawaiians.

As on Nihoa Island, the source of fresh water is a mystery. The present supply appears to be about 38 liters per day of undrinkable, guano-tainted water (Clapp and Kridler, 1977).

Thirteen species of vascular plants, mostly grasses, have been recorded. In addition, 24 species of birds have been recorded, 15 of which are seabirds. The Hawaiian monk seal and the green sea turtle are regular visitors in shallow waters.

## Gardner Pinnacles

Gardner Pinnacles, located at 25°0' N latitude and 167°55' W longitude, consist of two small volcanic rocks situated in the middle of the NWHI (Figure 10 and Plate 13). Its nearest neighbors are French Frigate Shoals (234 km to the southwest) and Laysan Island (408 km to the east-northeast). Barren, of no commercial value, and difficult to land on, these pinnacles are two of the least visited islands of the chain. Being the westernmost volcanic islands in Hawaiian waters, Gardner Pinnacles stand on the northeastern part of a bank which is 32 km wide and 80 km long with depths ranging between 8 and 36 fathoms (16 and 73 m).

The smaller, more northwestern of the two islands is about 77 m long and 31 m wide and rises to about 31 m at its peak. The larger island is about 215 m long and 154 m wide and rises to two distinct peaks. The larger of these peaks was formerly about 52 m high but blasting by the military in March 1961 to provide sites for first order astronomic and HIRAN stations has reduced its height somewhat.

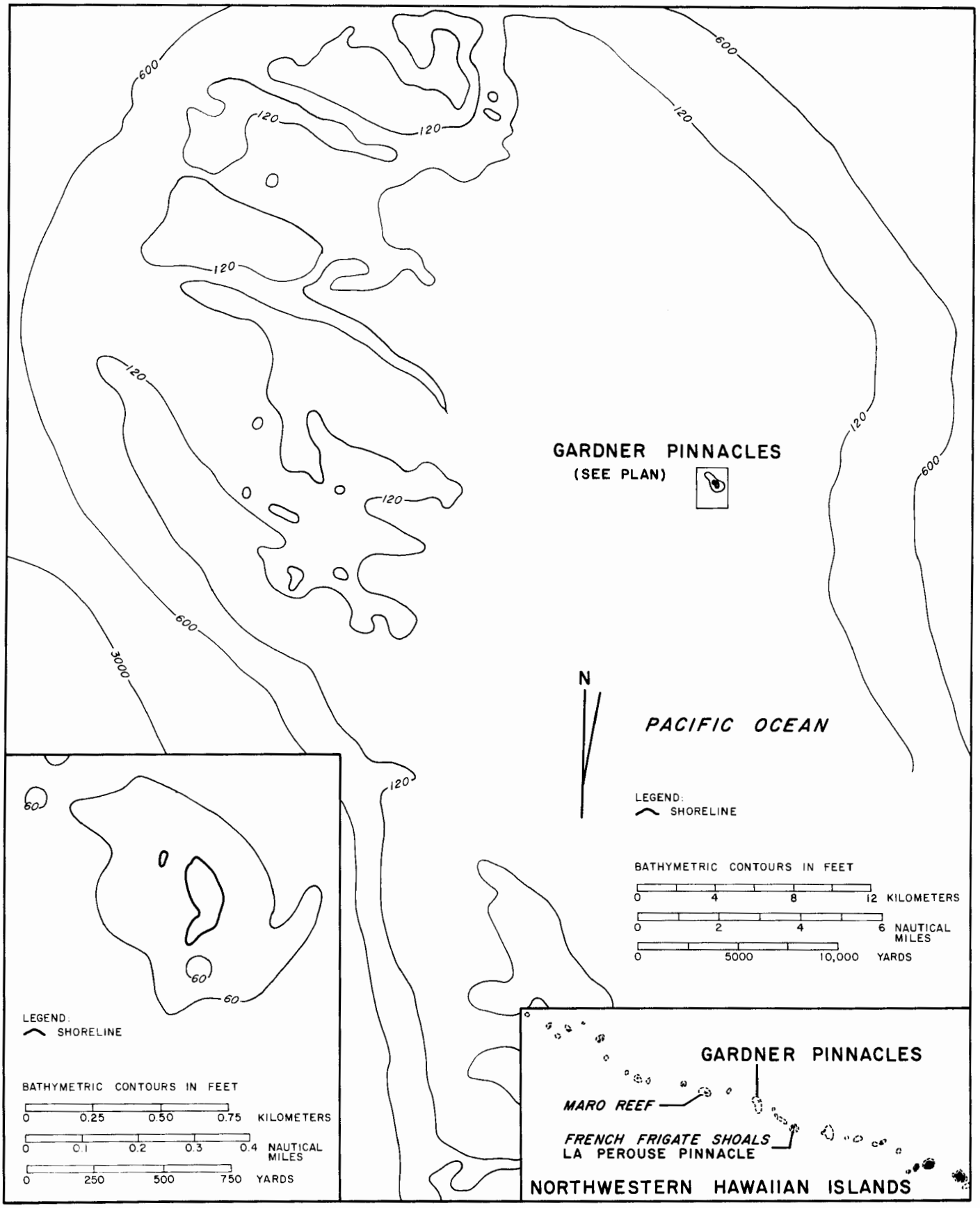



Figure 10. Gardner Pinnacles (from NOAA chart 19421)

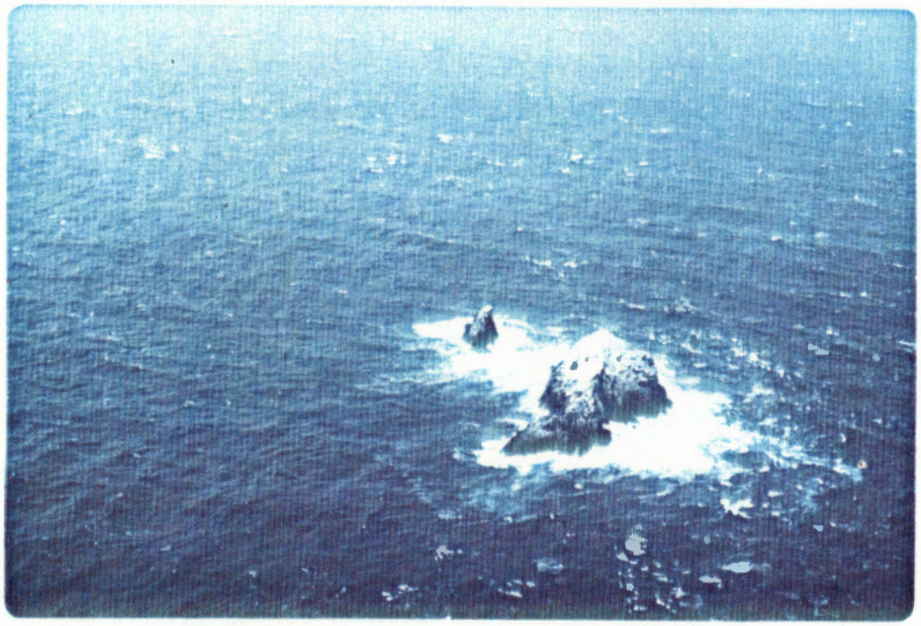


Plate 13. Gardner Pinnacles, aerial view looking north

Together the two islets comprise an area of about .013 sq km. The rocks are heavily coated with guano which, from a distance, gives them a snowcapped appearance. The cliffs are steep, but once a landing has been accomplished, one can walk around the base of the larger island and to both peaks (Clapp, 1972).

Only one vascular plant genus, *Portulaca*, is found on Gardner Pinnacles. Nineteen species of birds have been recorded, and the Hawaiian monk seal and the green sea turtle are uncommon visitors.

## Laysan Island

Laysan, the largest island of the NWHI, is located at 25°41' N latitude and 171°44' W longitude (Figure 11 and Plate 14). It is approximately 230 km east of Lisianski Island, 404 km northwest of Gardner Pinnacles, and 1,418 km northwest of Honolulu. The island is roughly rectangular in shape and about 3.6 sq km in area with a large saltwater lagoon occupying about one-fifth of the island's central depression. Laysan is a coral island ringed on its periphery by sand dunes; the beach crest and inland slopes are well vegetated.

The maximum crest elevations are just over 12 m and occur in a sand dune area at the northern end of the island. The beach crest varies in width from a narrow strip on the northwest and east to a width of about 200 m on the southwest and west. Inside the beach crest the landlocked lagoon varies considerably in shape and area with water level.

The original flora of Laysan Island was the most varied in the NWHI. Destruction of the vegetation by man and the introduction of rabbits resulted in the extinction of several species of birds and the movement of sand which altered some physical features of the island and partially filled the lagoon. At present, the vegetation has returned to a condition somewhat similar to the original.

The fringing reef surrounding the island varies from 100 to 500 m in width and is most extensive at the northwest end of the island. Inside the reef is a narrow, shallow channel which nearly encircles the island except for the south and southeast sides. A small boat can navigate in most parts of this channel at high tide. A natural break in the northwest reef provides a safe entrance for boats during most types of weather. Smaller breaks in the reef are present near the southwest and northeast corners of the island.

The reef consists of coral, calcareous algae, and the remains of shelled marine invertebrates. The lagoon consists of disintegrated coral which has been cemented together with guano. The result is a fine conglomerate with the pores closed to such a degree that it is nearly impenetrable by water. The island surface consists primarily of phosphatized coral sand.

Laysan Island has no supply of fresh water. Warner (1963) estimated that the 90 fathom (180 m) contour around Laysan Island encloses an area of about 544 sq km.

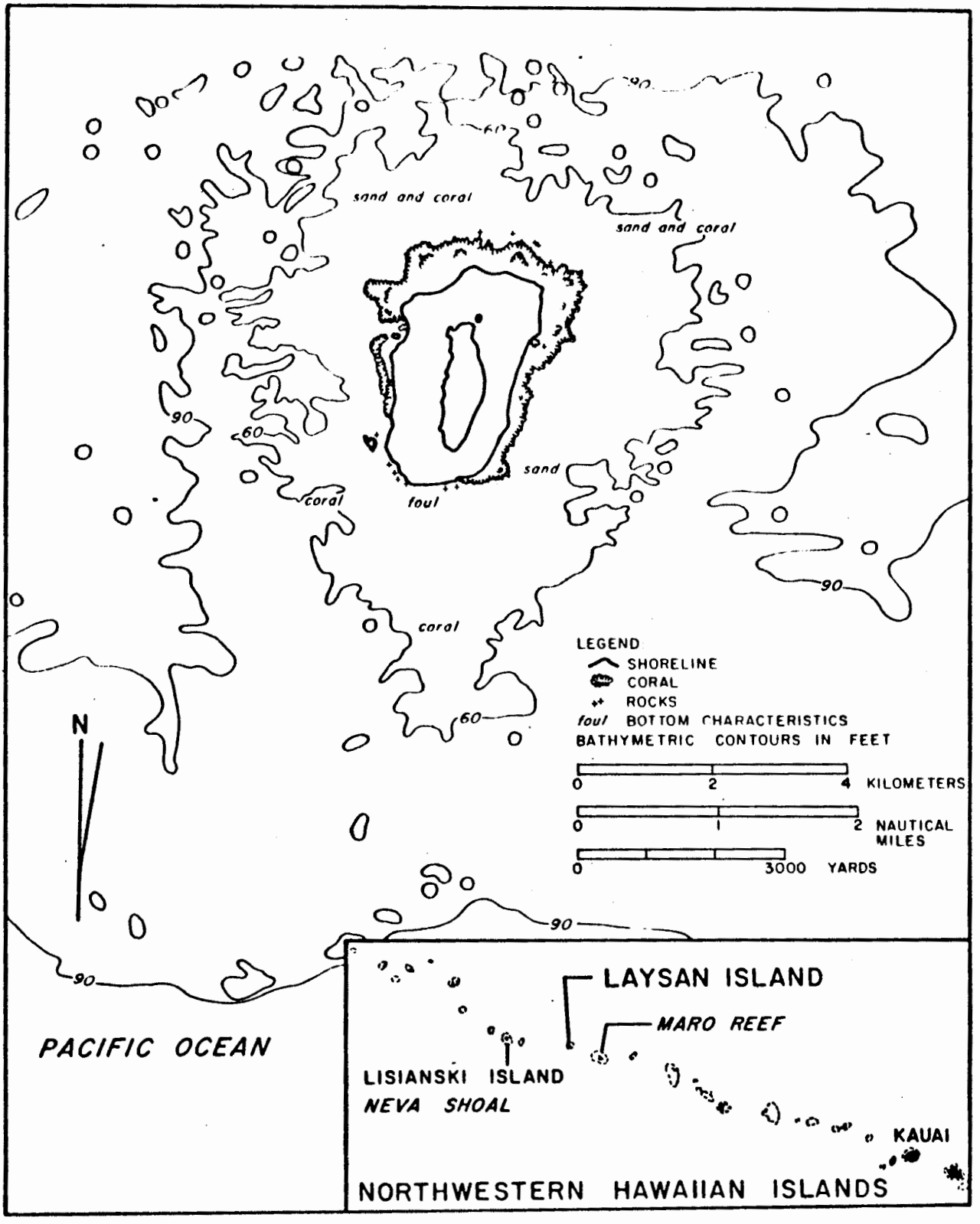



Figure 11. Laysan Island (from NOAA chart 19442)

Plate 14. Laysan Island, aerial view looking north. Visible engine is shut down to conserve fuel in low-level flight.

## Lisianski Island

Lisianski, a low sandy and coral island located at 26°02' N latitude and 174°0' W longitude (Figure 12), is approximately 1,810 km northwest of Honolulu and 230 km west of Laysan Island. The island has an area of approximately 450 acres and is situated at the northern edge of a large reef bank, Neva Shoals, which is about 169 sq km in area. Lisianski Island is approximately 1,829 m long, north to south, and 1,006 m wide, being somewhat wider to the north. Its circumference is about 5 km.

The island is ringed mostly by sandy and sand-coral beaches with the exception of the eastern side which is dominated by an exposed ledge of reef rock and small tidal pools. A small cove present near the middle of the west beach is designated as a small boat landing on hydrographic charts. There are only a few small coral heads in the lagoon area west of this landing, and a large area of clear water lies between the landing and the reef rock to the west. Towards the north end of this cove is a group of *Casuarina* trees under which previous expeditions have established campsites.

Presently, 42 species of vascular plants are known from Laysan Island. A rim of *Scaevola* growth covers the entire perimeter of the island with the densest growth along the north point and southward along the east beach and across the south end. Lush growths of bunchgrass, *Eragrostris*, attaining heights of up to 1 m cover the island's interior.

Fifty-nine species of birds have been recorded on Laysan Island; this is the largest total seabird population of any island in the group. Five of these species are endemic to the island and two species, the Laysan duck and finch, are endangered species. The Hawaiian monk seals are numerous; they use the beaches of Laysan Island as a hauling ground. Two reptiles, the green sea turtle and the snake-eyed skink, are also found on Laysan Island.

## Pearl and Hermes Atoll

Pearl and Hermes (Figure 13) is a low coral atoll situated toward the northwestern end of the Hawaiian Archipelago at 27°55' N latitude and 175°45' W longitude. It is approximately 2,090 km northwest of Honolulu and 140 km east-southeast of Midway Islands. This true atoll has been known as Pearl and Hermes Reef since two ships of corresponding names were wrecked there in 1822. In 1968, however, the State of Hawaii Department of Planning and Economic Development approved the name Pearl and Hermes Atoll, and this name was subsequently adopted by the U.S. Board of Geographic Names.

The fringing reef is roughly 69 km in circumference and open to the west. The enclosed elliptical area, whose long axis lies in a northeasterly direction, is approximately 32 x 18 km at the broadest dimensions. The area within the reef covers 370 sq km; the nine islands within the reef cover 0.3 sq km. Grass, North, Seal and Southeast Islands have established vegetation. Little North Island, which has continued to emerge since it was first reported as a sandbar awash at high tide, has

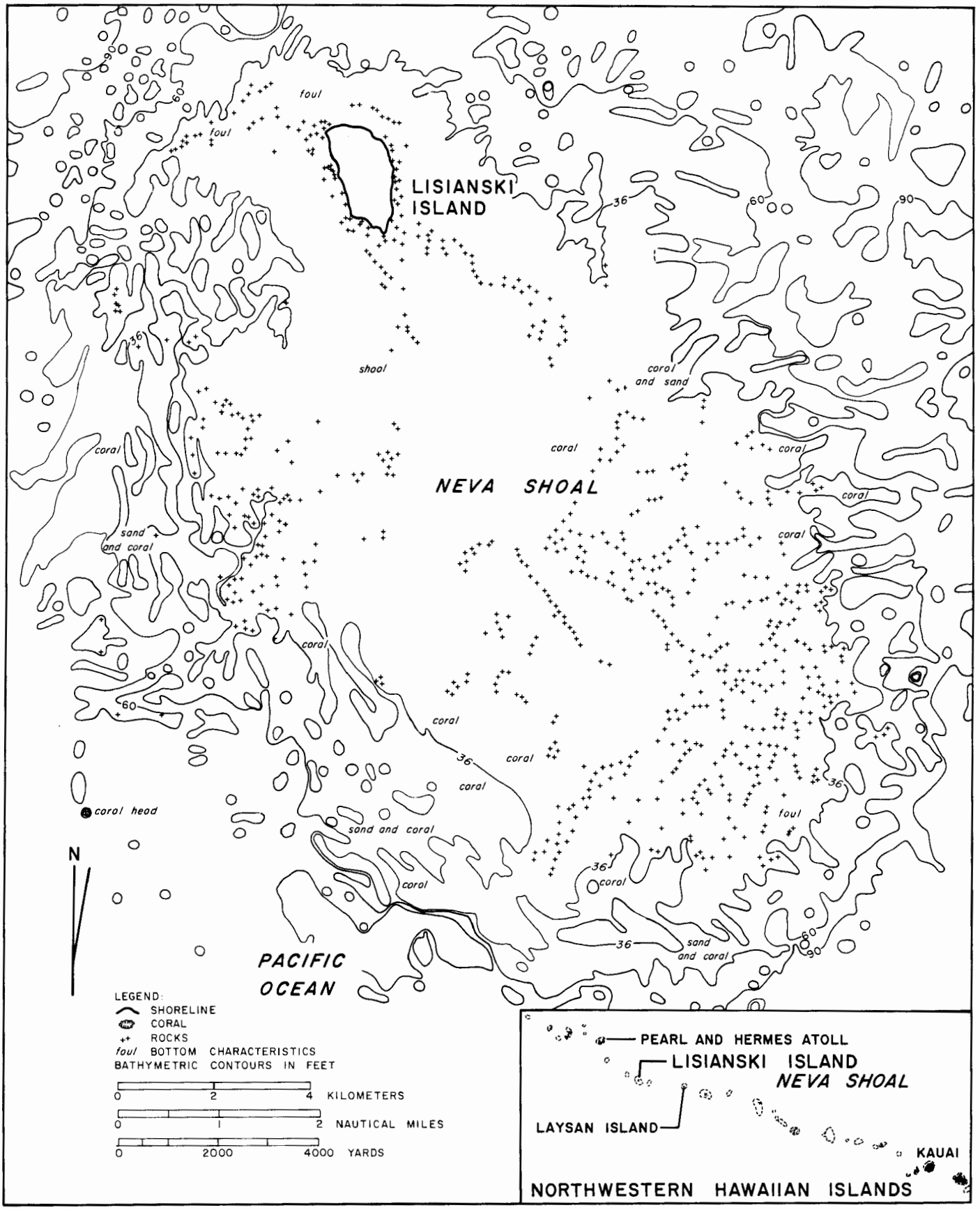



Figure 12. Lisianski Island and Neva Shoals (from NOAA chart 19442)

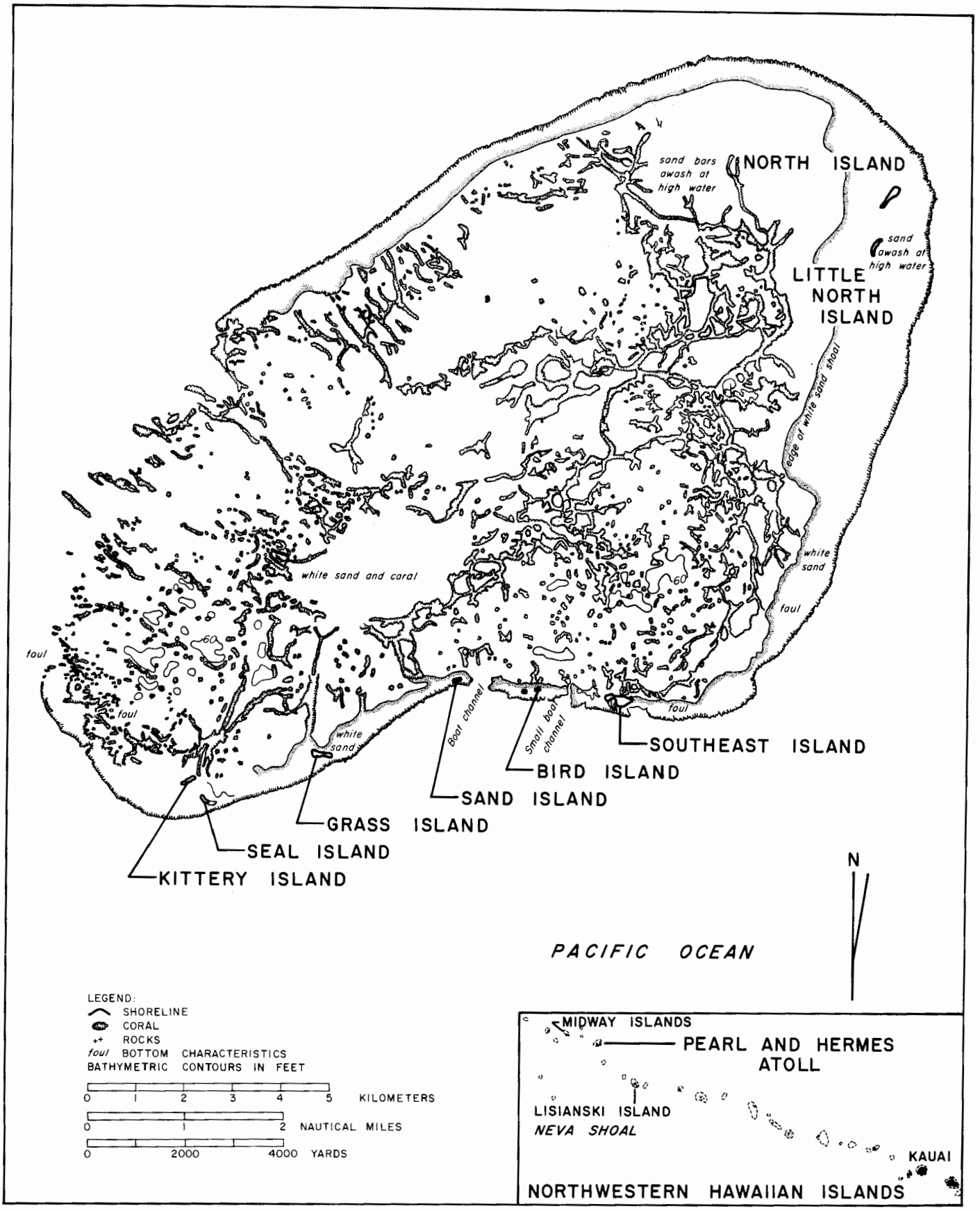



Figure 13. Pearl and Hermes Atoll (from NOAA chart 19461)

limited vegetation. Kittery Island is low and subject to occasional inundation despite its size and relative permanency. The remaining three islands--Bird, Planetree, and Sand--are shifting sandbars. Historical and recent data examined by Amerson et al. (1974) suggest that considerable changes in the topography of Pearl and Hermes Atoll have occurred in the past 100 years as a result of continuous shifting, splitting, and reforming of sandspits.

Twenty-five species of vascular plants, mostly grasses, have been observed on Pearl and Hermes Atoll. Thirty-seven bird species have been recorded, 17 of which are resident seabirds. The Hawaiian monk seal is a common resident breeder and is present year-round.

Maro Reef

Maro Reef is an almost totally submerged shoal lying between Gardner Pinnacles to the southeast and Laysan Island to the northwest (Figure 14). This shoal area is centered at 25°22' N latitude and 170°35' W longitude. One rock, extending approximately 1 m out of the water at high tide, is the only emergent land. This rock is not inhabited by any terrestrial species. The total submerged area of the reef encompasses approximately 52,000 acres. This reef area consists of numerous coral heads and rocks amid sandy flats and channels at depths of 1 to 10 fathoms (2 to 20 m). Much of this reef area is unsurveyed and poorly charted.

Maro Reef lies on the southeast side of the surface of an oval-shaped seamount. Extending out from Maro Reef, the seamount is approximately 15 to 20 fathoms (30 to 40 m) deep and the sides drop sharply to depths of 250 to 500 fathoms (500 to 1,000 m).

NWHI seamounts

The NWHI area contains several seamounts as well as emergent islands. While these seamount areas are thought to have great potential for fisheries development, there are relatively little supporting data. Recently, researchers aboard the TOWNSEND CROMWELL found that several seamounts in the Midway Islands-Kure Atoll area were incorrectly charted.

Since investigations of the NWHI seamounts will be a major component of the University of Hawaii Sea Grant and tripartite studies, a brief descriptive summary is presented. This information was obtained from the 1972 season survey of trawling grounds in the North-Central Pacific Ocean conducted by the Japanese Government (JAMARC).

In general, the seamounts of the NWHI are unlike the fishing grounds of the continental shelf, being very rough on the bottom with numerous outcroppings, protuberances, and rock areas. For this reason, net damage occurs frequently on the seamounts, with about 80 percent of the trawls resulting in snags and 20 percent resulting in net tears.

Table 2 gives a brief descriptive summary of the seamounts.

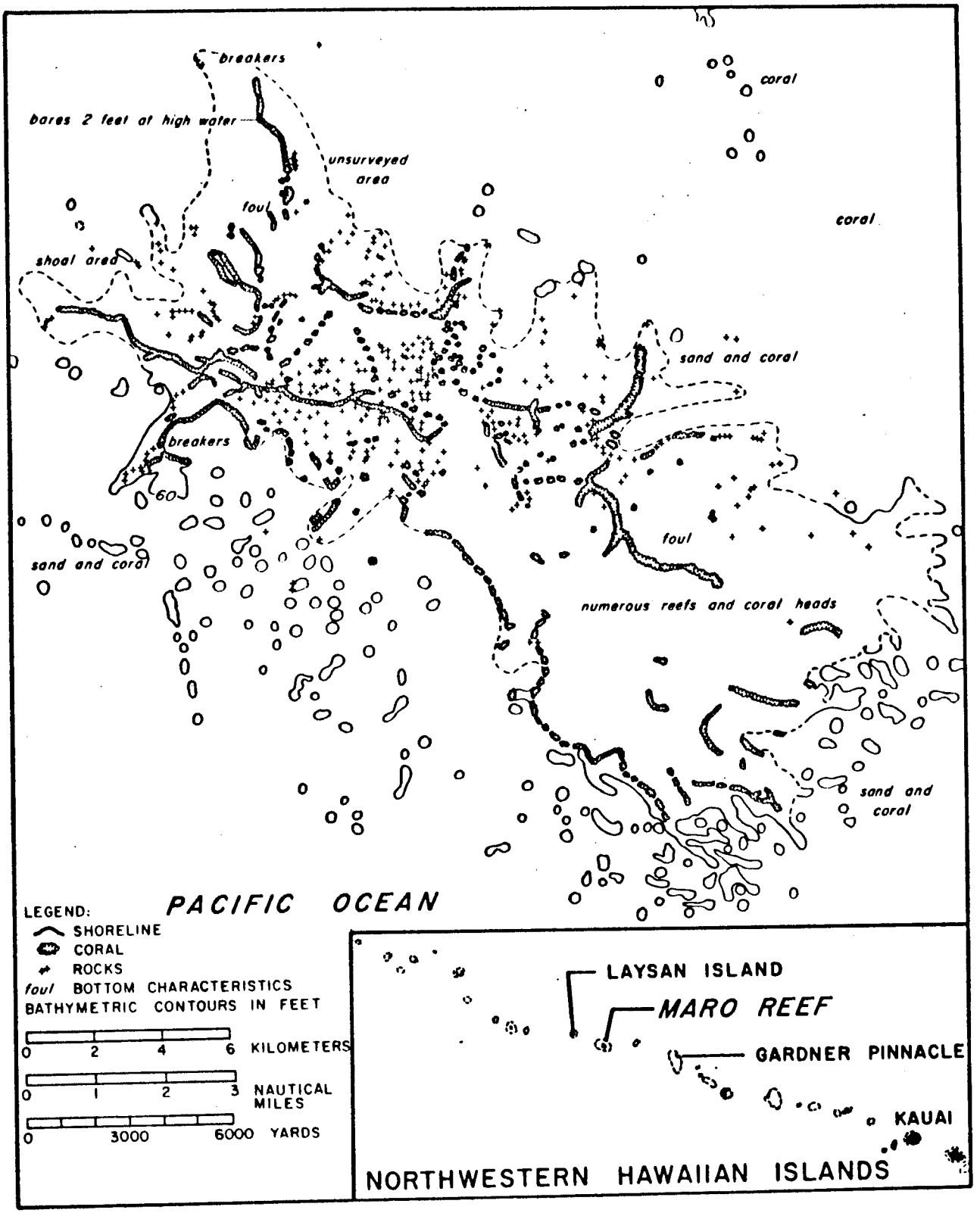



Figure 14. Maro Reef (from NOAA chart 19441)

TABLE 2. BRIEF DESCRIPTIONS OF THE SEAMOUNTS OF THE NWHI

| Seamount or Bank | Latitude | Longitude | Approximate Minimum Depth | Approximate Dimensions |
|---|---|---|---|---|
| Seamount northwest of Niihau Island (unnamed) | 22°35' N<br>22°42' N | 160°57' W<br>161°06' W | 30 fathoms (60 m) | Roughly circular seamount 8 km in diameter |
| Nihoa-Necker Bank (unnamed) | 22°50' N<br>23°20' N | 162°05' W<br>163°44' W | 30 fathoms (60 m) | Large bank area approximately 120 km NW-SE and 50 km SW-NE with 5 seamounts |
| Brooks Bank | 23°55' N<br>24°16' N | 166°40' W<br>167°02' W | 11 fathoms (22 m) | Three circular steep-sided seamounts--two approximately 10 km in diameter and one approximately 4 km in diameter |
| St. Rogatien Bank | 24°10' N<br>24°21' N | 167°03' W<br>167°11' W | 12 fathoms (24 m) | Large shallow topped oval seamount approximately 7 km E-W and 10 km N-S |
| Seamount north-northwest of St. Rogatien Bank (unnamed) | 24°35' N | 167°15' W | 30 fathoms (60 m). | Small seamount approximately 5 km in diameter |
| Raita Bank | 25°15' N<br>25°39' N | 169°23' W<br>169°45' W | 9 fathoms (18 m) | Oval seamount approximately 20 km NE-SW and 10 km NW-SE |
| Northhampton Banks | 25°75' N<br>25°40' N | 171°58' W<br>172°36' W | 20 fathoms (40 m) | Two seamounts, unsurveyed to date |
| Pioneer Bank | 25°50' N<br>26°06' N | 173°20' W<br>173°38' W | 17 fathoms (35 m) | Oval seamounts 20 km E-W and 11 km N-S |
| Unsurveyed bank northwest of Lisianski Island | 26°17' N | 174°30' W | 35 fathoms (70 m) | Unknown to date |
| Salmon Bank (East) | 26°50' N<br>27°07' N | 175°22' W<br>175°40' W | 500 fathoms (1,000 m) | Seamount 18 km in diameter |
| Salmon Bank | 26°45' N<br>27°04' N | 176°20' W<br>176°40' W | 30 fathoms (60 m) | 11 km N-S and 6 km E-W |
| Ladd Seamount | 28°25' N<br>28°32' N | 176°30' W<br>176°44' W | 42 fathoms (85 m). | 5 km N-S and 4 km E-W |
| Nero Bank | 27°58' N | 177°50' W | 41 fathoms (82 m) | Unsurveyed |
| Kure Island Seamount | 28°54' N | 179°37' W | 90 fathoms (180 m) | 2.5 km x 2.66 km |
| Hancock Seamount (SE) | 29°47' N | 179°03' E | 130 fathoms (260 m) | Oval topped seamount with maximum diameter of approximately 1.75 km |
| Hancock Seamount (NW) | 30°15' N | 178°43' E | 131 fathoms (263 m) | Flat topped seamount, 1 x .8 km |

# The Inhabited Islands

## Kure Atoll

Kure Atoll, located at 28°25' N latitude and 178°10' W longitude, is an oval-shaped atoll which is 9 km at its maximum diameter and 91 km west-northwest of Midway Islands at the extreme northwest end of the Hawaiian Archipelago (Figure 15 and Plate 15). Kure is the northernmost atoll in the world and although located nearly 1,958 km northwest of Honolulu, the atoll is part of the City and County of Honolulu, State of Hawaii and is part of the State Wildlife Refuge.

Green Island, the only permanent land of the atoll, is located in the southeast sector of a nearly continuous coral reef which encloses a shallow lagoon (Plates 16 and 17). An outer reef almost completely encircles the lagoon except for passages to the southwest. Gross et al. (1969) estimated that this reef comprises an area of about 5 sq km.

Green Island, which has a maximum elevation of 8 m, is crescentic in shape with a long axis curving from the north to west and is approximately 2 km long by .6 km wide. The shape of its extremities changes seasonally, however. The south side of the island is bordered by a fringing reef.

Green Island is bordered by white coralline sand beaches. On the ocean side, the beach is narrow and fairly steep with much coral rubble and debris strewn about. The beaches on the lagoon side are wider, as much as 70 m, and considerably less steep, with finer grain sand. At the present time, the beaches of approximately the northern one-third of the island are closed by order of the Fish and Wildlife Service and the National Marine Fisheries Service to prevent interference with Hawaiian monk seal populations.

A U.S. Coast Guard LORAN (long-range navigation) station is situated on Green Island. The major features of the station are a 190-m signal tower, barracks, signal/power and transmitter buildings, a pumphouse, seven fuel tanks, a 20-m antenna, and a 1,230-m crushed coral runway (Plate 18).

To the west of Green Island are three sandbars known collectively as Sand Island. These islets are variable in size and shape throughout the year and are sometimes washed away during the winter months.

Kure Atoll is a wildlife refuge under the jurisdiction of the Hawaii Division of Fish and Game, Department of Land and Natural Resources (see section on legal status of NWHI). Under the terms of the lease with the Hawaii State Government, the Coast Guard is obliged to protect all species of turtles, the Hawaiian monk seal, and all other animal (except rodents), bird, and plant life on the island.

There are no trees native to the island but almost complete coverage is provided by a shrub, *Scaevola taccada*, which grows to a height of approximately 2 m. Numerous paths through this *Scaevola* growth bisect the island.

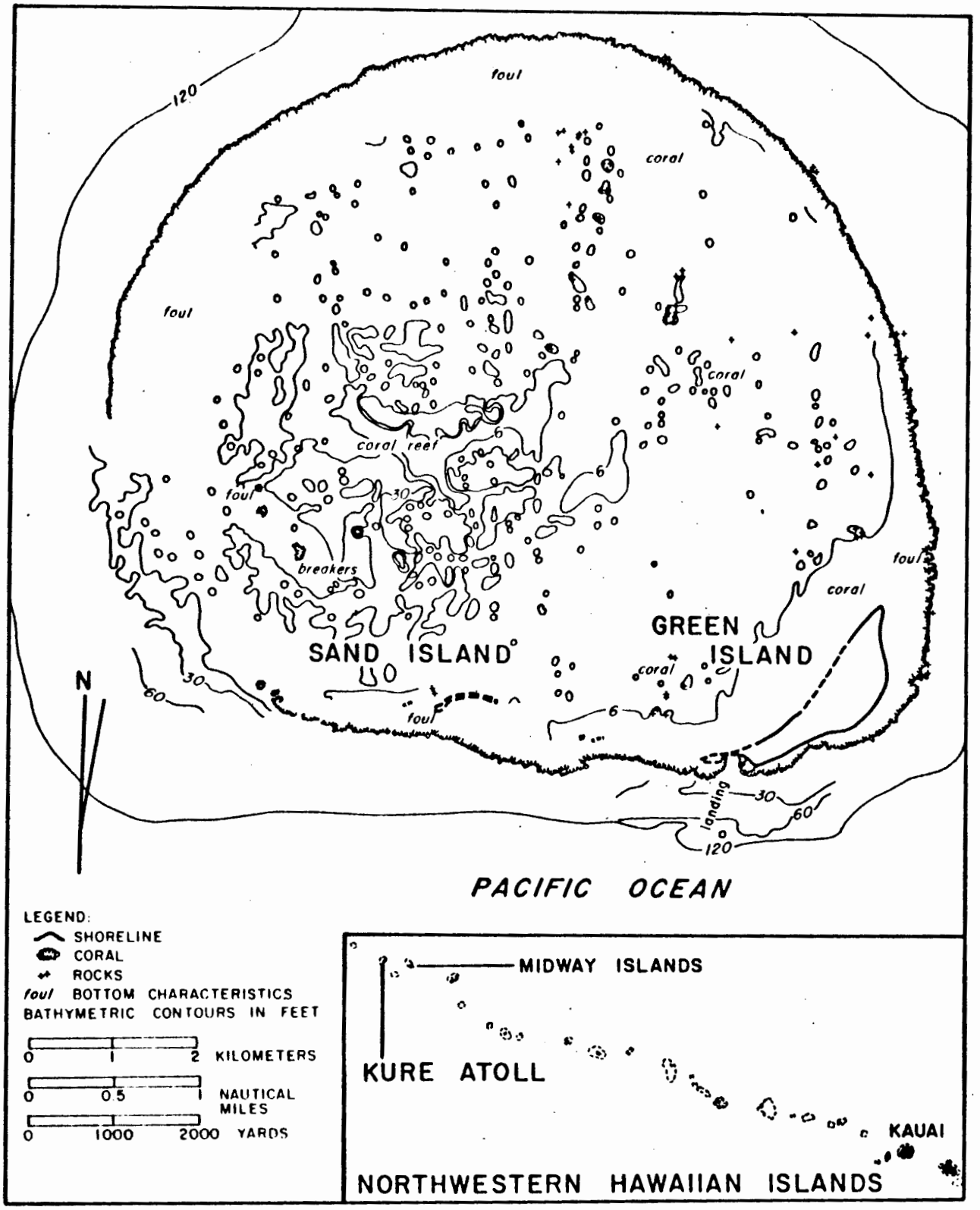



Figure 15. Kure Atoll (from NOAA chart 19483)

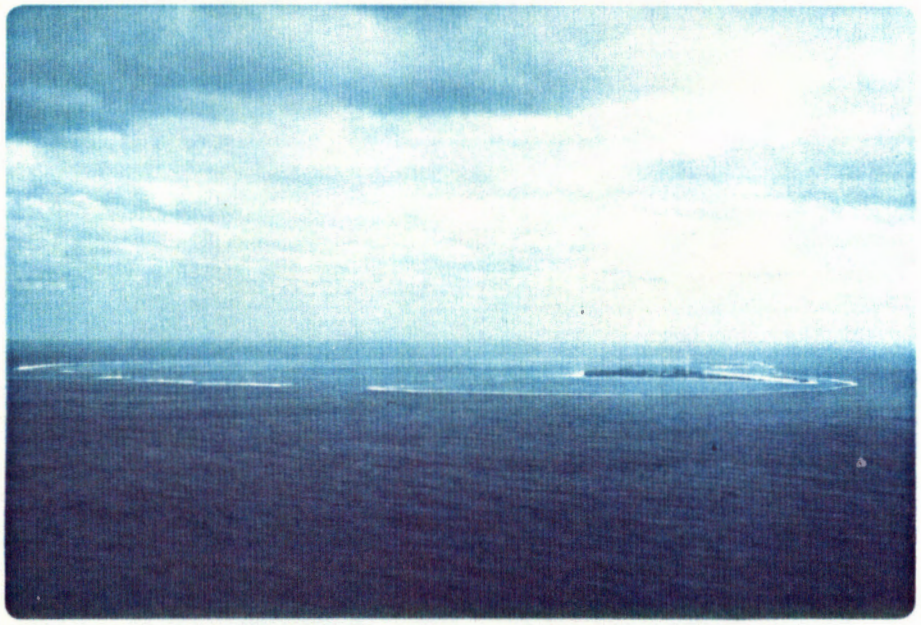


Plate 15. Kure Atoll, aerial view looking east-southeast

Plate 16. Lagoon Beach, Kure Atoll, looking north. LORAN station tower is visible at right.

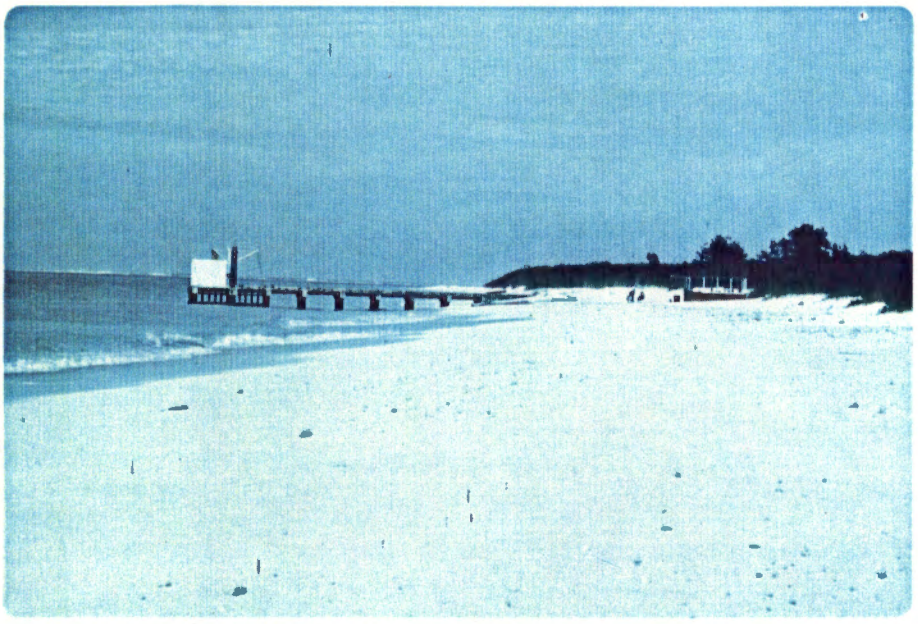


Plate 17. Lagoon Beach, Kure Atoll, showing small concrete pier and winch used for lowering Boston Whalers. Building at right is Kure Beach Club.

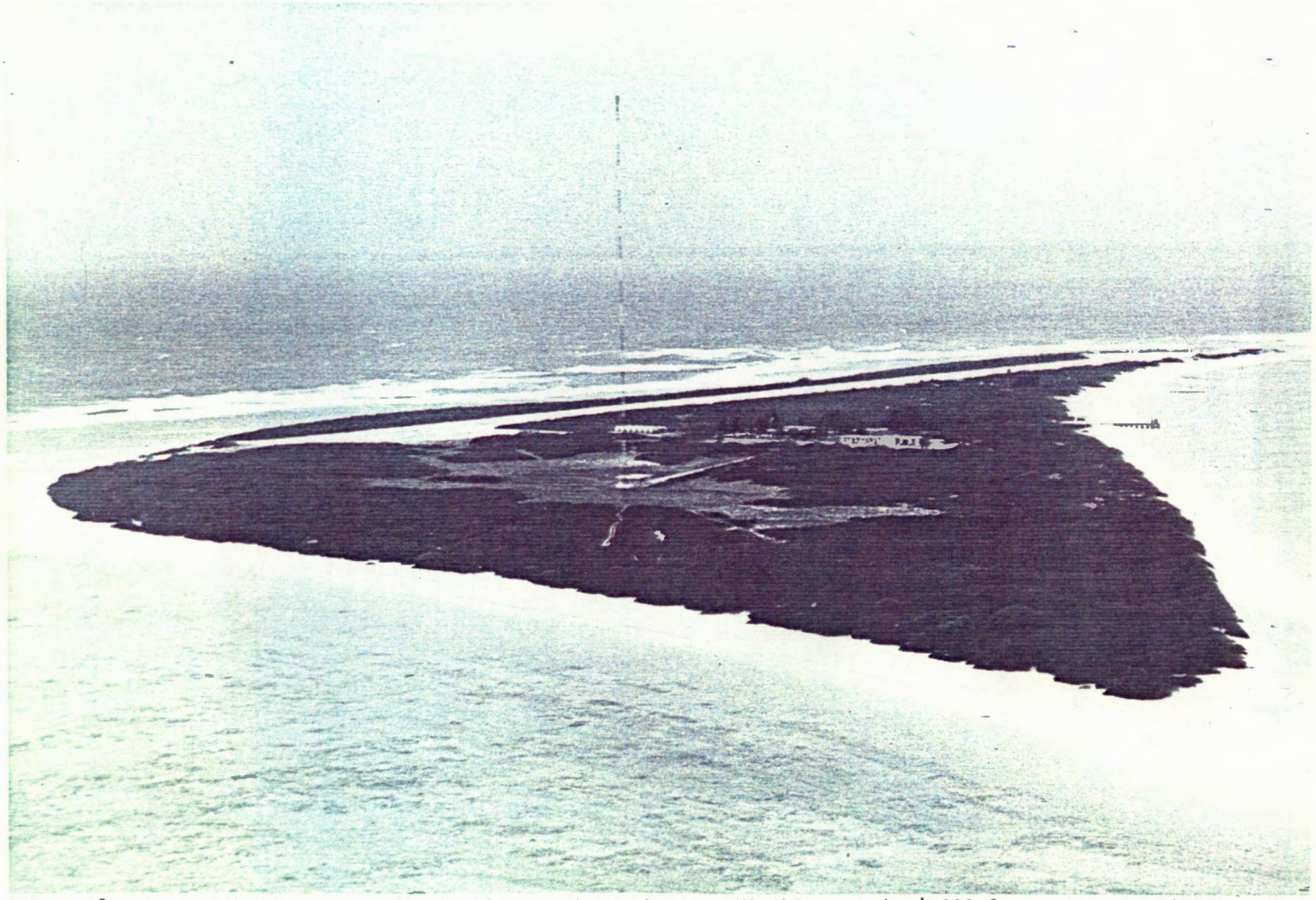


Plate 18. Green Island, Kure Atoll, looking south-southeast. Visible are the 4,000-ft runway, the LORAN tower with seven diesel fuel tanks directly behind, the barracks and signal buildings, and the small pier. The lagoon is to the right and the fringing reef is on the ocean/runway side of the island.

Kure Atoll, like many of the other islands in the NWHI, supports breeding colonies of many species of seabirds (15) and serves as a regular resting point for migratory shorebirds (13 species). The most spectacular seabirds are the "gooneys," a collective term applied to the Laysan and black-footed albatross. These birds occupy the island in huge numbers from October to July during which time breeding, hatching, and rearing of the young takes place.

The Hawaiian monk seal and the Polynesian rat are resident mammals on Kure Atoll. Sea turtles are occasionally seen on the beaches and in the lagoon. Mosquitoes, however, are absent.

A total of 46 vascular plant species have been recorded, the majority (31) of which were intentionally introduced. A detailed report of all previous studies conducted on the flora and fauna of Kure Atoll can be found in Woodward (1972).

Conducting research on Kure Atoll. The primary objective of the Coast Guard installation at Kure Atoll is to maintain the operation of the LORAN C station (Plate 19). Any outside activities that do not interfere with this mission are permitted and even welcome and the Coast Guard makes every effort to cooperate. Kure Atoll is an isolated, unaccompanied duty station manned by personnel on a one-year tour and, as such, most of the personnel are interested and willing to assist in any research activities that may provide some diversion from their daily routine.

The limiting factor for conducting research work at Kure Atoll is billeting space. Under normal conditions there is adequate living and sleeping space for 4 to 6 researchers; however, visitors and repair crews are not uncommon. For this reason it is advisable to contact the Commanding Officer at Kure Atoll directly (address at end of section) as well as the Aids to Navigation Office in Honolulu (546-7130).

Due to its isolation, extreme safety is practiced during diving operations at Kure Atoll. The Commanding Officer is responsible for all personnel on Kure Atoll and his permission is required to enter the water at any time. However, this is mainly a formality to insure that individuals do not enter the water alone. A shark watch is maintained on shore while swimmers are in the water. While sharks are observed to be abundant in the lagoon and on the seaward side of the reef, there have been no attacks reported.

Research divers must notify Coast Guard personnel of the approximate location of the dive and time of return. When a Coast Guard Boston Whaler and coxswain are available, research dives may be conducted by boat. Since the Boston Whalers are Coast Guard property, a Coast Guardsman must be aboard, however. Presently this is on a volunteer basis, but it will soon be a regular duty so boats should be accessible to researchers at almost any time. Since Boston Whalers do not routinely leave the lagoon, in months of calm weather divers can easily swim from the inner lagoon edge across the reef flat to the seaward reef face. The fringing reef on the south side of Green Island is accessible from the beach, which is approximately .5 km from the barracks building. This area has been observed to have the most abundant live coral reef communities of the atoll.

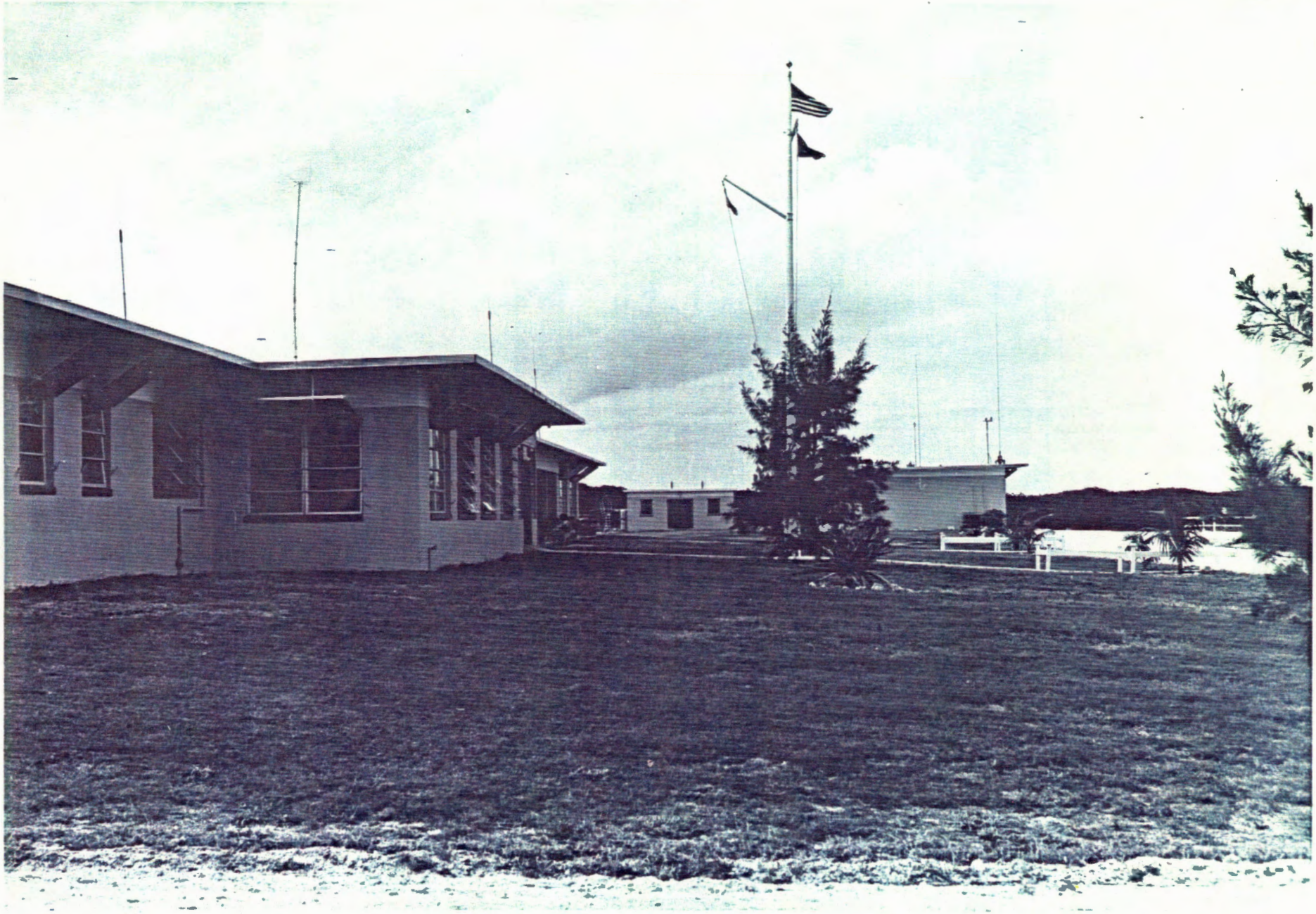


Plate 19. Kure LORAN station. The barracks/mess/recreation building is in the left foreground. The signal building is to the right.

No fresh fish are taken by Coast Guard personnel due to the possibility of contacting ciguatera, but lobsters are caught. Since construction on the island has been kept to a minimum and the human population is small, the marine ecosystem of Kure Atoll is in an extremely undisturbed state.

Since only empty SCUBA tanks are allowed onboard C-130's and since Kure Atoll is not equipped with an air compressor, diving tanks were filled at Midway Islands. With the termination of helicopter flights from Midway Islands to Kure Atoll in April of 1978, however, the filling of dive tanks at the Midway Islands dive shop is no longer possible. Therefore, in order to employ SCUBA at Kure Atoll, a compressor must be shipped from Honolulu. Transportation of a crated or pallet-secured compressor aboard Coast Guard aircraft presents no problem and diesel fuel, gasoline, and electrical power to run the compressor at Kure Atoll are available.

There is adequate freezer space for specimens or materials in the barracks galley, and there is abundant space for setting up monitoring equipment, microscopes, or drafting equipment. A photo lab is available for black and white film processing.

Food provided by the Coast Guard is excellent and inexpensive. There are also numerous recreational facilities including nightly films.

All things considered, Kure Atoll is an excellent location, both zoogeographically and logistically, to conduct research. Transportation and lodging are available at no cost and personnel are helpful and friendly. Since Commanding Officers are rotated on a yearly basis and since all activities at Kure Atoll are under his discretion, it is advisable to communicate plans directly with the current Commanding Officer. These requests, as well as any questions that cannot be handled through the 14th Coast Guard District Headquarters in Honolulu, should be addressed to:

Commanding Officer
USCG LORAN Station, Kure Atoll
U.S. Naval Station
Box 36
F.P.O. San Francisco 96614

Surface support facilities.

*USCG LORAN station personnel.* Two officers (the Commanding Officer and the Executive Officer) and approximately 21 enlisted men make up the complement of the LORAN station.

*Boats.* The station has two 17-ft Boston Whalers, one powered by an 85 hp outboard motor and the other by a 40 hp outboard motor. These crafts are used for local SAR missions, but their primary function is for recreation (water skiing and skin diving). When not in use for Coast Guard priority work and with the Commanding Officer's approval, these boats, provided with a qualified coxswain familiar with local waters, are available to research personnel.

*Living accommodations.* Individual rooms with a single bed, locker, shelves, desk, and air conditioner are available. Visiting researchers are housed in empty enlisted men's rooms. At the east end of the barracks are the galley, recreation decks, sick bay, ham radio shack, photo lab, and library. The galley includes a walk-in chill box, two walk-in freezers, and a dry storage area. Laundry facilities are also available. However, there are no provisions for women scientists on Kure Atoll.

*Food.* Three meals a day are prepared in the galley and are available at a modest price to visitors: breakfast for $.55, lunch or dinner for $1.35, and brunch on Sunday for $1.15. In order to keep morale at Kure Atoll high, the Coast Guard provides the best food possible. Beer is available at $.25 per can, but no other alcoholic beverages are allowed on the island.

*Vehicles.* The station is provided with two Dodge power wagon pickup trucks. These trucks are equipped with trailer hitches for launching and towing the Boston Whalers.

*Communications.* Teletypewriters are available with radio circuits providing direct communications with the 14th Coast Guard District radio station on Oahu. An AM package is used for communication with Midway Islands, as well as a UHF transceiver for direct communications with flights from Midway Islands. Portable transceivers are provided for working with ships and for SAR operations. In order to communicate with Kure Atoll by radio, the Aids to Navigation Office, 14th Coast Guard must be contacted (546-7130).

*Medical assistance.* A hospital corpsman is assigned to the station and has at his disposal a well-equipped office and sick bay. Naval hospital facilities are available on Midway Islands.

*Piers and wharfs.* There is a small concrete pier located on the lagoon side of Green Island approximately .25 km from the barracks. The pier is equipped with a winch for launching and pulling out the small boats (see Plate 17). However, most launching and pull-outs are accomplished simply by backing a trailer across the sandy beach to the lagoon.

There is a deepwater channel on the southwest side of the atoll that allows most vessels entry into the lagoon. Vessels may anchor in the lagoon and use small launches to reach Green Island. The maximum depth of the lagoon is 7 fathoms (14 m) but the lagoon has numerous small patch reefs so care must be exercised.

*Transportation.* In the past, Kure Atoll was serviced by twice weekly helicopter flights from Midway Islands. These flights were terminated in April 1978. Thus, presently the only air access to Kure Atoll is by Coast Guard semimonthly C-130 flights from Honolulu (see section on transportation for details).

*Water.* Fresh water is collected by catchment from the roofs of the buildings. Rain is consistent during the year and normally provides adequate, though limited supplies of fresh water.

*Fuel.* Fuel and lube oil are supplied yearly to Kure Atoll by tanker; gasoline is supplied in 55-gallon drums. There is a sufficient supply of gasoline which may be purchased in order to operate SCUBA compressors, boats, or any other gasoline-driven apparatus that may be required for research work.

*Power.* Electrical power is provided by a diesel generator and is available for electric compressors or other research equipment.

Midway Islands

Midway atoll lies about 2,100 km west-northwest of Honolulu at 28°12' N latitude and 177°23' W longitude near the extreme western end of the Hawaiian Archipelago. Two islands, Sand and East (Plate 20), situated on the southeastern sector of the atoll, are the only inhabited lands; the rest of the atoll is composed of a circular coral reef with a circumference of 24 km (Figure 16). The reef elevation varies from 1.5 m above sea level to totally submerged. Of the two islands, Sand is larger and since 1939 has been the site of the Midway Naval Station and an active runway. Sand Island measures 2.4 km long and 1.6 km wide. About 1.6 km east of Sand Island is East Island, which is triangular and measures about 2.0 km long and 1.2 km wide.

The entrance to the lagoon is to the south between Sand and East Islands. The atoll has undergone extensive changes through the efforts of man, including importation of soil, grasses, shrubs, and ironwood trees and dredging of channels and harbors. For this reason the area around Midway Islands does not represent a natural environmental situation as does the neighboring atoll of Kure. However, Midway Islands is relatively accessible by air and, with the facilities to dock large ships, it makes an excellent rendezvous point for scientists and research vessels.

The U.S. Navy currently maintains a fully equipped station, manned by 900 military personnel and 700 dependents, with all the facilities of a small city. However, in the summer of 1978, with the removal of dependent-related facilities such as schools and commissaries, the status of Midway Naval Station will change to an unaccompanied duty station.

Midway Islands is best known as the site of the Battle of Midway, June 3-5, 1942, which is considered to be the turning point of World War II when the U.S. gained control of the Pacific.

Conducting research on Midway Islands. Midway Islands are administered by the U.S. Navy as a defense installation, and the waters for an area of 8 km around the islands is designated as a Naval Defense at Sea Area. For this reason the Navy does not readily encourage research work by civilians. To even enter the islands special clearances must be obtained (see section on permits and clearances). However, there are abundant billeting space, eating facilities, boats, compressors, and a dive shop. Wharf space is abundant and almost any type of vessel can be accommodated.

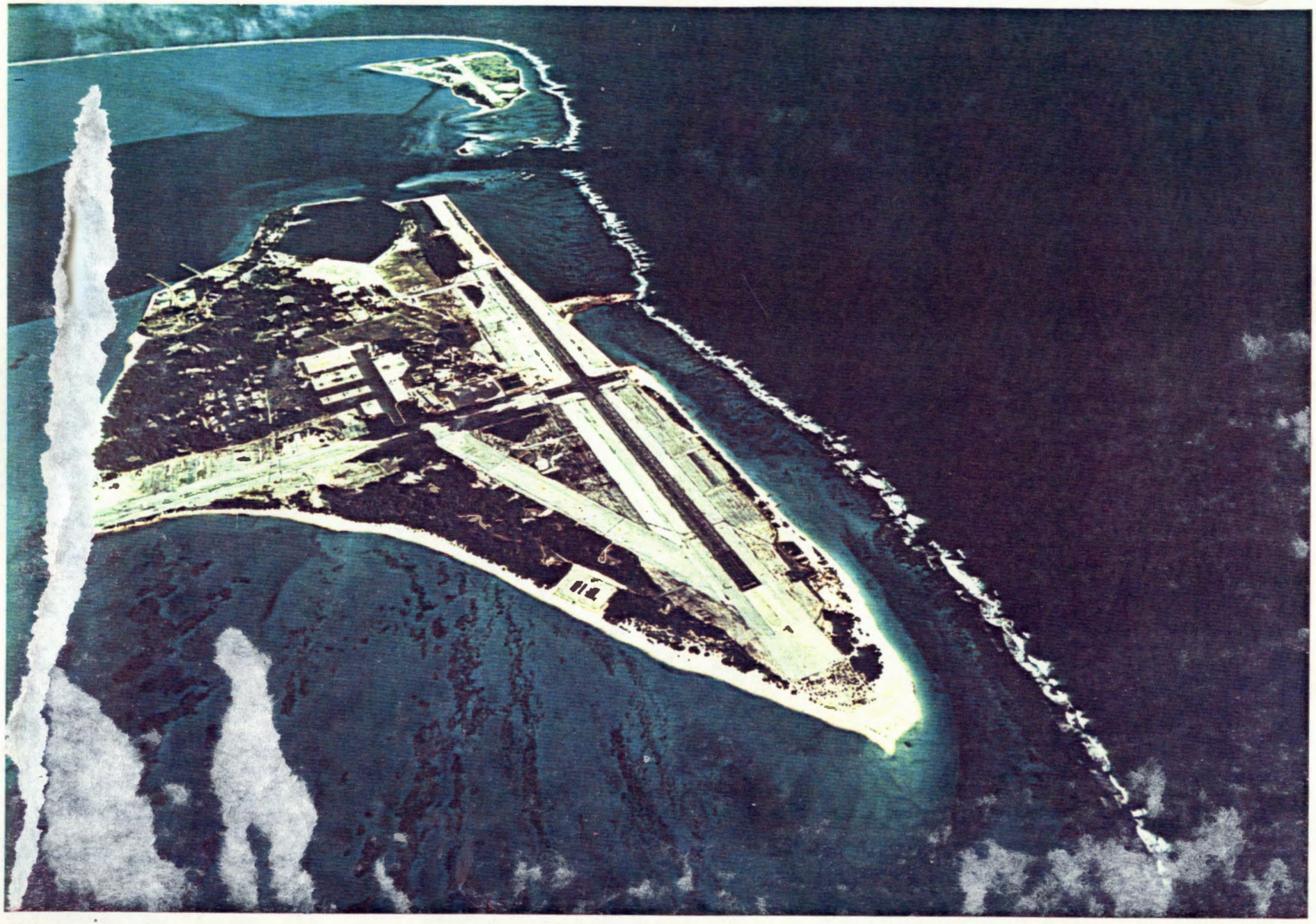


Plate 20. Midway Islands looking north. Sand Island is in the foreground; East Island in the background.

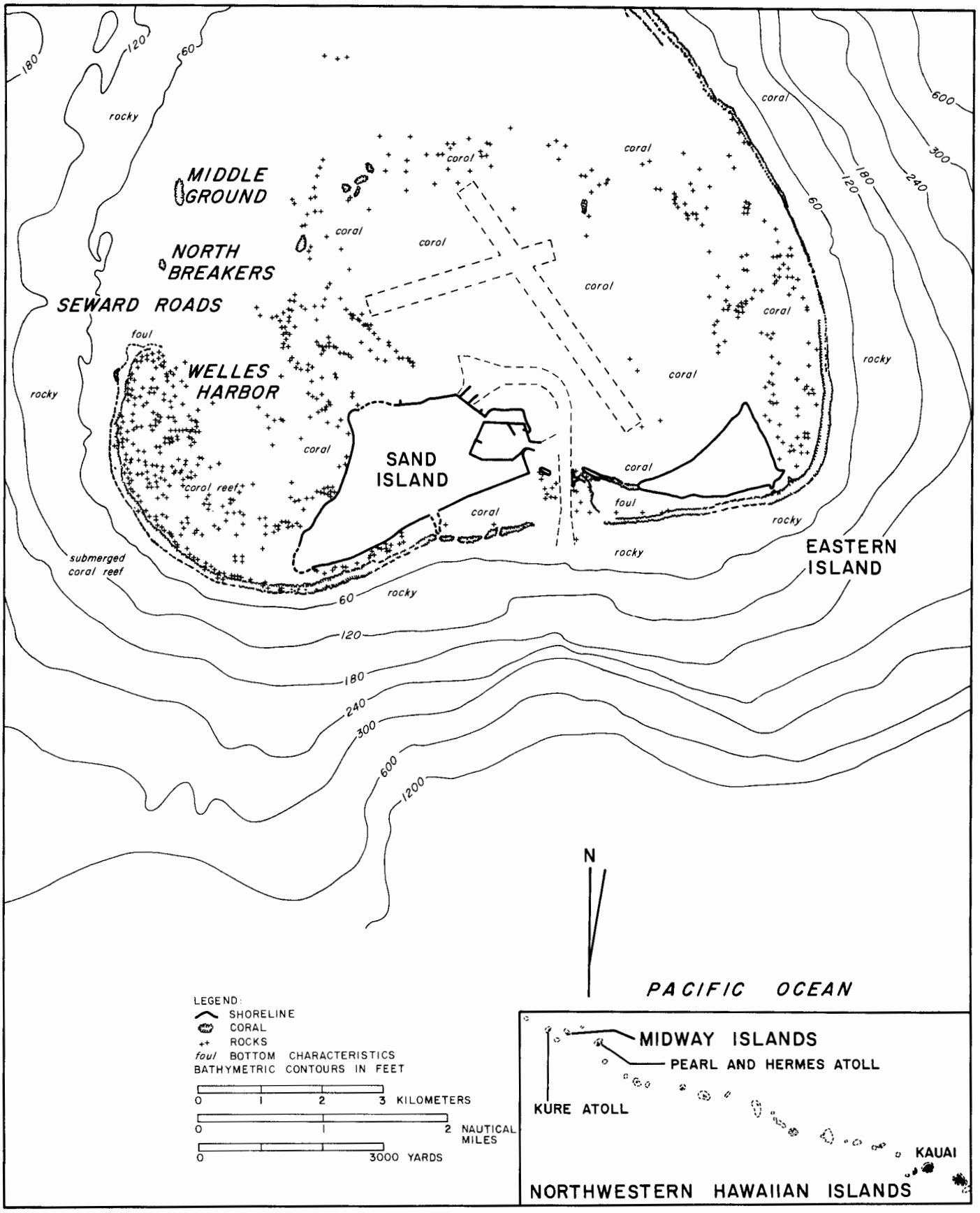



Figure 16. Midway Islands (from NOAA chart 19481)

It is recommended that, unless there is some aspect of Midway atoll that is truly unique in terms of marine resources, field research be conducted on Kure Atoll.

Surface support facilities.

*Living accommodations.* Since Midway is exclusively a military reservation there is no permanent commercial or civilian housing available. Limited temporary housing is available, pending clearance from the Commanding Officer. The price for this temporary housing is $5.85 per night single occupancy and $3.85 per night double occupancy. This housing is usually available in the Bachelor Officers' Quarters. Each room has a private bath. There are also provisions for women researchers on Midway.

*Food.* There is a variety of places to eat on Midway ranging from enlisted men's mess halls to officers' clubs and snack bars. There is also a naval exchange, retail commissary, and package stores with a comparatively wide selection of merchandise.

*Communications.* There is commercial telephone service to anywhere in the world from Midway. However, phone service from Midway is only by credit card or collect calls.

*Boats, compressors, and dive services.* The Koral Kings Dive Club of Midway Naval Station maintains a number of dive boats, an air compressor, and a retail dive shop and is able to repair most dive equipment. There is also a small boat launching ramp adjacent to the dive shop which allows easy access to the lagoon. These facilities are available to research personnel and arrangements can be made for boat rental and compressor usage by contacting:

Koral Kings Dive Club
Midway Naval Station
F.P.O.
San Francisco, California 96614

*Piers and wharves.* On the lagoon side of Sand Island is a dredged deepwater harbor equipped with two 1,000-ft concrete wharves (Plate 21). The Navy also maintains two ocean-going tug boats to provide assistance to vessels entering the harbor (Plate 22). Currently, the Navy is investigating the possibility of allowing factory ships to dock at Midway to service fishing fleets in the NWHI.

*Water.* As on Kure Atoll, fresh water is collected by catchment methods and, except in periods of drought, is available in limited quantities for all purposes. Brackish water is pumped from wells drilled into the coral rock of the island. This water is not potable, however.

*Fuel and power.* There is fuel oil, gasoline, and limited electrical power available from the Navy on Midway Islands. Arrangements to purchase fuel should be initiated by mail to the Commanding Officer in the initial clearance letters.

Plate 21. Midway Lagoon. Small boat launching ramps are in the center foreground and two 1,000-ft concrete piers are in the background.

Plate 22. Midway Harbor, view from end of concrete pier looking toward Sand Island

*Freezer space.* While most of the freezer plant space at Midway is utilized by the stores of the Naval Station there are limited spaces available for items requiring freezing. Again, arrangements should be initiated in the letters of intent to the Commanding Officer.

## French Frigate Shoals

French Frigate Shoals (Figure 17) is a coral atoll situated almost at the midpoint of the 2,600-km Hawaiian Archipelago. It is approximately 1,330 km north-northwest of Honolulu and approximately 1,300 km southeast of Kure Atoll. French Frigate Shoals lies between the latitudes of 23°37' and 23°52' N and longitudes of 166°03' and 166°20' W. Of the 14 small named islands in the lagoon, 13 are low and sandy and cover approximately .4 sq km. The fourteenth named island, La Perouse Pinnacle, is volcanic rock. Islands with well-established vegetation include Tern, Trig, East, and Whale Islands. Skate and Little Gin Islands, although quite large, are only sparsely vegetated. Two other islands, Gin and Disappearing, are without vegetation, and La Perouse, in spite of its size and height, supports no vegetation. The rest of the islands, Bare, Mullet, Near, Round, and Shark, are sandbars that shift continuously. Three other sandy islets are submerged during high tide.

The atoll consists of a crescent-shaped reef on a 20-fathom (40 m) deep oval platform whose long axis is 31 km in a northwest to southeast direction. There is a double crescentic reef; the almost continuous outer arc is 52 km long while the broken inner arc is 30 km long. The resulting lagoon is 12 km wide at its midpoint. The crescent tips point west and are 25 km apart. La Perouse Pinnacle lies between these two tips; it is 10 km southeast of the northern tip and 15 km northwest of the southern tip.

Tern Island (Plate 23), the largest island in the atoll, is located near the northwest tip of the crescent. This man-made island is almost exactly 1 km long east-northeast to west-southwest. Steel pilings driven to an approximate depth of 10 fathoms (20 m) and standing 2 m over the mean tide level surround each end of the island and extend along the west-northwest side of the island.

Tern Island is presently the site of a U.S. Coast Guard LORAN station whose complement is normally one officer and 18 enlisted men. A 77 m wide runway extends the length of the island and is composed of packed, fine crushed coral. Four buildings, several fuel and water tanks, a 40-m antenna, a small boat davit, and a tennis-basketball court are on the western third of the east-southeast side of the island. Two wooden piers are located near the western end of the west-northwest side. Adjacent to these piers is a 10-fathom (20 m) deep, 123 x 200 m turning basin, which connects southward around the west end of the island to the 3.7 km long vessel channel leading to the ocean.

The station is supplied by ship several times a year. Electrical power is available, as is fresh water; the latter is rain water obtained from a roof catchment system.

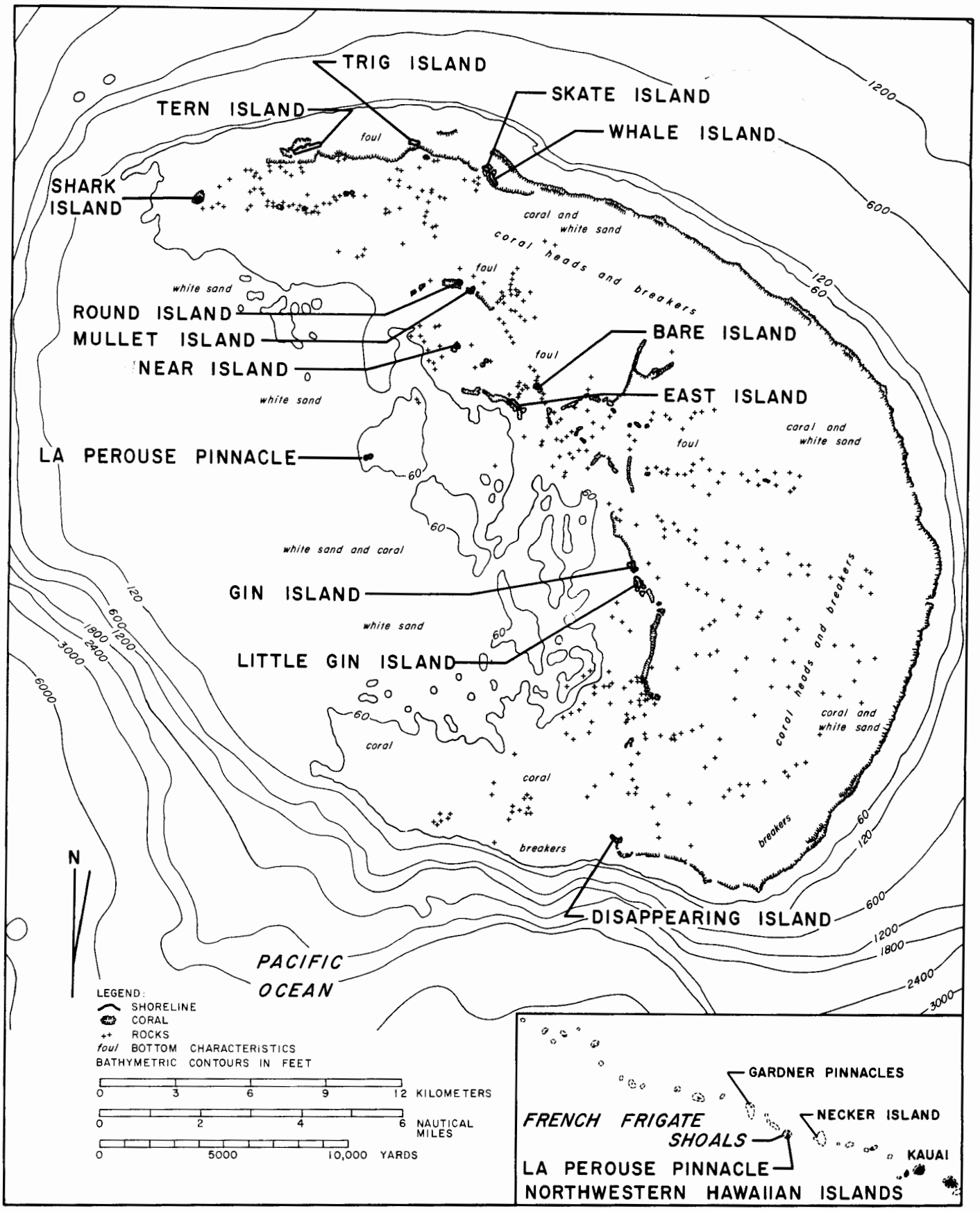



Figure 17. French Frigate Shoals (from *Marine Atlas of Hawaii: Bays and Harbors*, 1974)

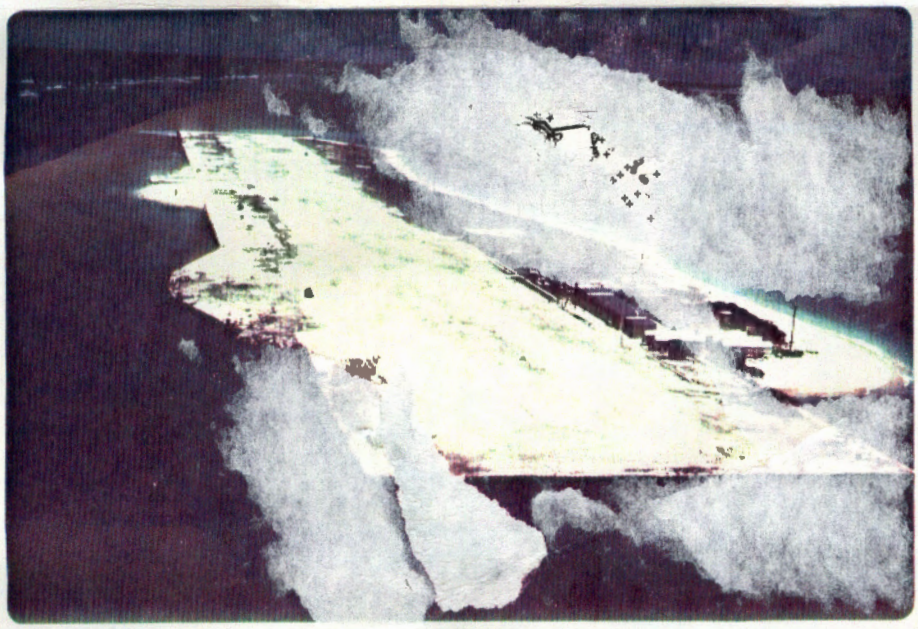


Plate 23. Tern Island, French Frigate Shoals

Research conditions at French Frigate Shoals are currently in a state of flux. Presently, while the Coast Guard is maintaining the LORAN station on Tern Island, all of the facilities and accommodations provided by the Coast Guard (boats, billeting, messing, power, communications) are very similar to those described for Kure Atoll. In addition, the Fish and Wildlife Service maintains a 17-ft Boston Whaler at Tern Island that is accessible to research personnel pending authorization by the Refuge Manager.

However, French Frigate Shoals is no longer accessible by Coast Guard C-130 supply flights due to dense populations of sooty terns which present a potentially serious danger to landing and departing aircraft. French Frigate Shoals is now serviced by air by a small charter private aircraft which is unavailable to research personnel. While the sooty terns usually occupy the island only from February to August, the population remained at French Frigate Shoals for the entire year of 1977. For this reason, and with the current timetable calling for deactivation of the Tern Island LORAN station in July of 1979, the Coast Guard is not considering reactivation of the semimonthly supply flights. This means that the only means of reaching French Frigate Shoals is by surface transportation, either by Coast Guard Buoy Tender (see section on transportation) or charter vessel.

As a result of the decision to deactivate the Coast Guard facilities at French Frigate Shoals, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service have filed a joint proposal to convert several of the Coast Guard buildings into a small-scale research station to begin operation in 1980. This proposal calls for deactivation of the runway and provides for living accommodations and a generator for approved research project personnel. Because this proposal is currently in a preliminary phase, the Refuge Manager of the Hawaiian Islands National Wildlife Refuge recommends that research plans for work at French Frigate Shoals should not include this natural environmental research facility until the status of the proposal becomes more definite.

# CLIMATE IN THE NORTHWESTERN HAWAIIAN ISLANDS

Climatological data available for the NWHI are primarily from French Frigate Shoals, Midway Islands, and Kure Atoll where man-made installations and operational personnel are located. Since these stations are located at the approximate middle (French Frigate Shoals) and northwestern end of the NWHI chain, the extrapolated climatic data can be used to describe conditions on the uninhabited islands.

In the high southeastern islands of the Hawaiian Archipelago, the high mountains strongly modify the climate. In contrast, in the NWHI the low profile and small area of the islands and atolls do not greatly modify the weather.

The prominent feature of the air circulation across the tropical Pacific and the Hawaiian Islands is the general east to west flow of the tradewinds. In the central North Pacific, the trades blow from the northeast quadrant and represent an outflow of air from the Pacific anticyclone, a region of high pressure. This Pacific high and tradewind zone moves north to south seasonally reaching the northernmost positions in May to September, at which time the trades prevail 80 to 95 percent of the time in the high Hawaiian Islands. From October to April, the Hawaiian Archipelago is positioned to the north of the heart of the trades and, as a result, the frequency of tradewinds decreases to 50 to 80 percent of the time. In general, this pattern characterizes the Hawaiian climate as a two-season year.

## KURE ATOLL, MIDWAY ISLANDS, AND THE NORTHWESTERN END OF THE HAWAIIAN ARCHIPELAGO

The climate at Kure Atoll, Midway Islands, and the northern portion of the Northwestern Hawaiian Islands is influenced by both marine tropical and marine Pacific air masses and the surrounding ocean, depending on the season.

During the summer the Pacific anticyclone (Pacific high) becomes dominant with the ridge extending across the Pacific north of Midway Islands and Kure Atoll. This places the region under the influence of the easterlies with marine tropical and tradewinds prevailing. During the winter months, especially from November to January, the Aleutian low moves southward over the North Pacific, displacing the Pacific high. The Kure-Midway region is then affected by either the marine Pacific or marine tropical air, depending on the intensity of the Aleutian low and/or the Pacific high.

Figure 18 (data extracted from Kure station logbooks, Woodward, 1972) shows the semimonthly wind direction at Kure Atoll for the years 1961-68. From November to February the winds were variable, but with a strong westerly component, which in some years is not consistent. Winds were also variable from March to June and from September to October, but with

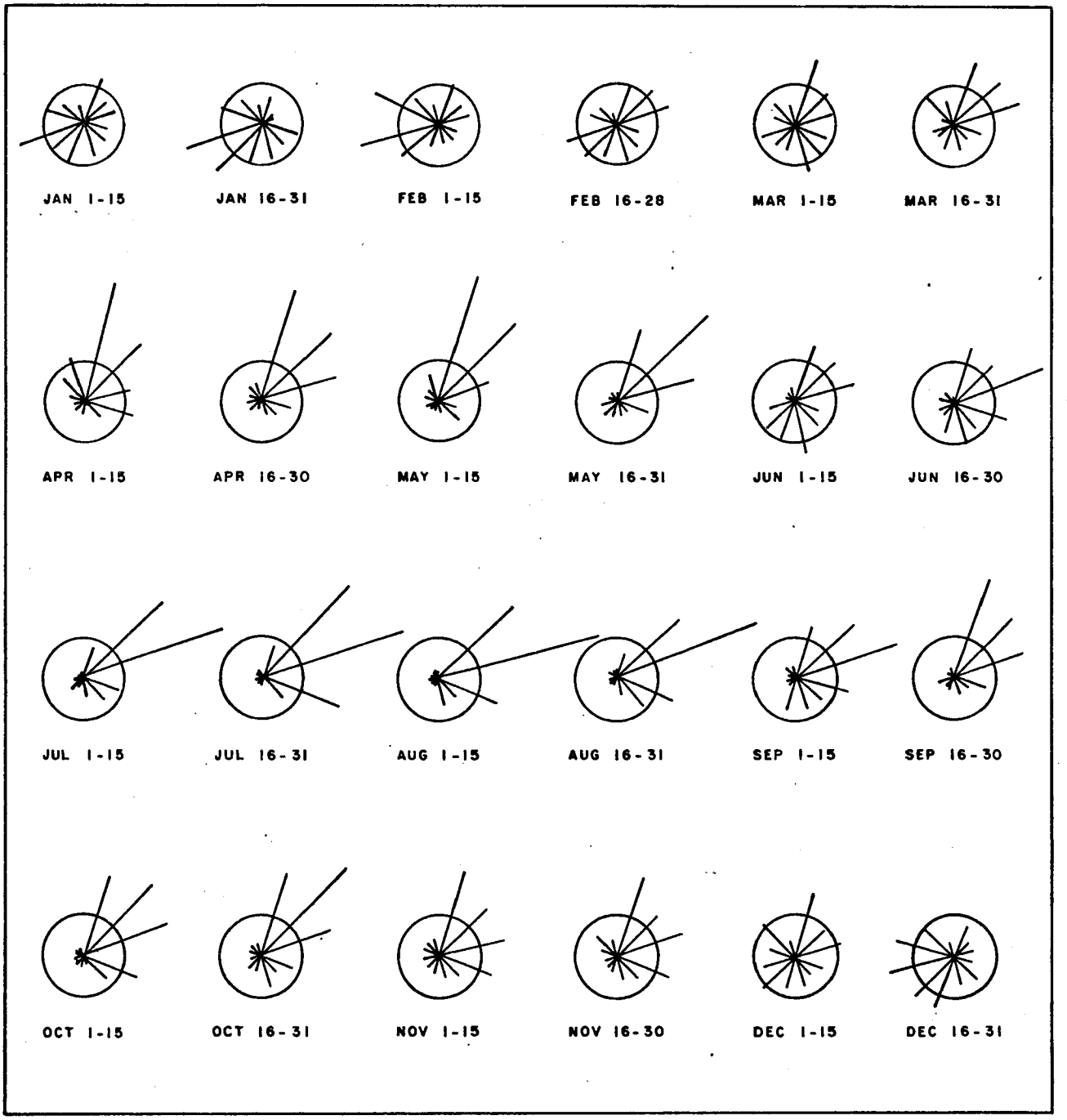



Figure 18. Wind direction at Kure Atoll by semimonthly periods (1961-68) expressed as percentages. Circle indicates 10 percent total wind. (From Woodward, 1972.)

a major easterly component. The northeast trades were consistent in July and August when almost all winds came from the east.

Wind speed (Figure 19) ranges from 0 to 46 knots (0 to 8, Beauford scale) with a yearly average of about 4 to 7 knots. Although there is no consistent yearly pattern, there is a tendency for the strongest winds to occur in winter and early spring and the weakest winds in summer.

Although there is a yearly variation in the average semimonthly temperature (Figures 20 and 21), the pattern of temperature change throughout the years (seasonal change) is fairly constant. The average maximum temperature varies about 20°F (from 65° to 85°F) and the average minimum temperature varies about 17°F (from 58° to 75°F). The absolute variation is 39°F to 99°F. January and February are usually the coldest months and July, August, and September the warmest. The average temperature begins to increase between April and June and begins to decrease in September or October. The next section dealing with the climate at French Frigate Shoals and the more southerly sections of the Hawaiian Archipelago shows that minimum temperatures are significantly lower in the Midway-Kure region in the winter due to the effect of the Aleutian low pressure system.

At Midway Islands rainfall averages about 40 inches annually (rainfall was not measured at Kure Atoll). March is the driest month and December, January, and February are the wettest months. Heavy rainfall is most common; light rain and drizzles are very rare. Thunderstorms are relatively uncommon, averaging six a year, mostly in the summer months.

Severe tropical storms or typhoons are rare in the Hawaiian Islands, while winter storms are common, resulting in a noticeable increase in precipitation, winds, and high seas.

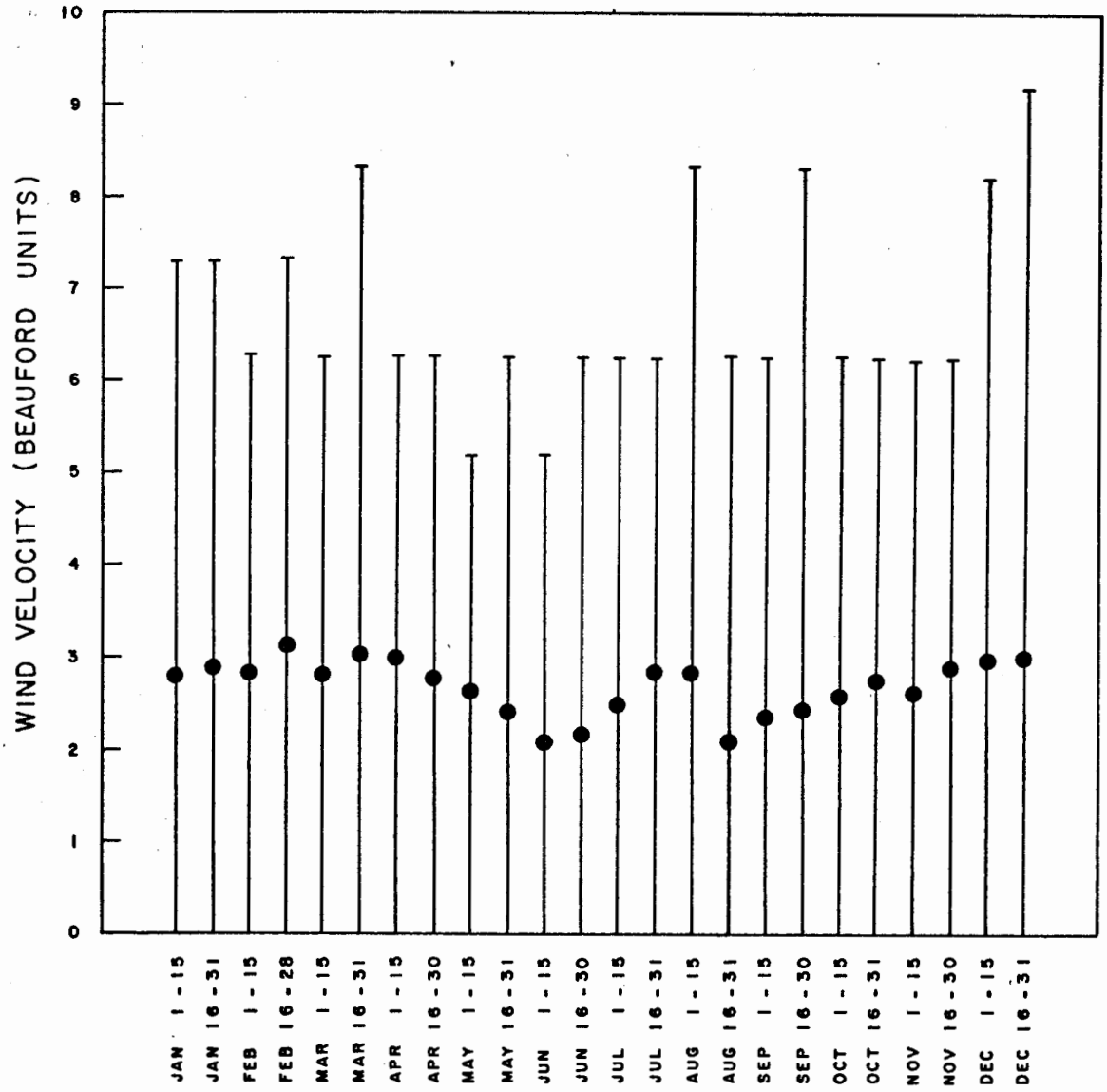
Sea surface temperature varies from a low of 69°F in February to a high of 80°F in August and September. Salinity varies from 35.2°/oo in April and May to 35.0°/oo from November and through February (Seckel, 1962).

These climatic data, as well as personal communication with persons who have worked in the NWHI, indicate that the late spring through early fall months (April through October) is the optimal period for conducting field research in the NWHI.

## FRENCH FRIGATE SHOALS AND THE LOWER PORTION OF THE NWHI

The information in this section is from a 12-year (1951-62) summary of data collected by personnel of the U.S. Coast Guard LORAN station at French Frigate Shoals and recorded by the Air Weather Service (MATS), Climatic Center, USAF.

The major difference between the weather at the lower part of the NWHI chain including French Frigate Shoals and the Kure-Midway area is the effect of the Aleutian low pressure system in the winter months. During the winter months, the Pacific anticyclone, which influences French Frigate Shoals with prevailing easterly trades, is only slightly affected by the




BEAUFORD SCALE:

| | | |
|---|---|---|
| 0 = 1 knot | 4 = 13 - 18 knots | 8 = 39 - 46 knots |
| 1 = 2 - 3 knots | 5 = 19 - 24 knots | 9 = >47 knots |
| 2 = 4 - 7 knots | 6 = 25 - 31 knots | |
| 3 = 8 - 12 knots | 7 = 32 - 38 knots | |

Figure 19. Mean wind velocity and range of wind speed in Beauford Scale at Kure Atoll, 1961-68. (From Woodward, 1972.)

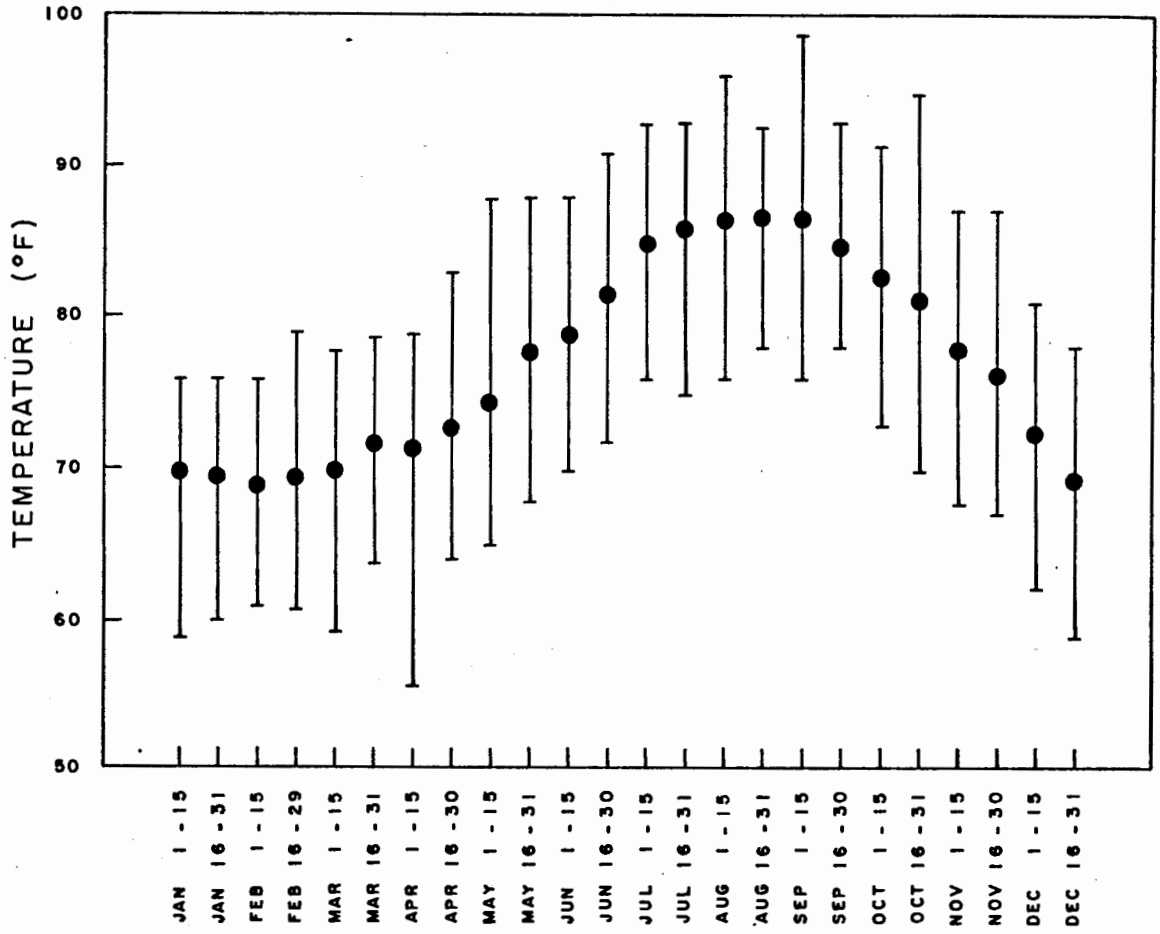



Figure 20. Average semimonthly maximum temperatures and ranges at Kure Atoll, 1961-68. (From Woodward, 1972.)

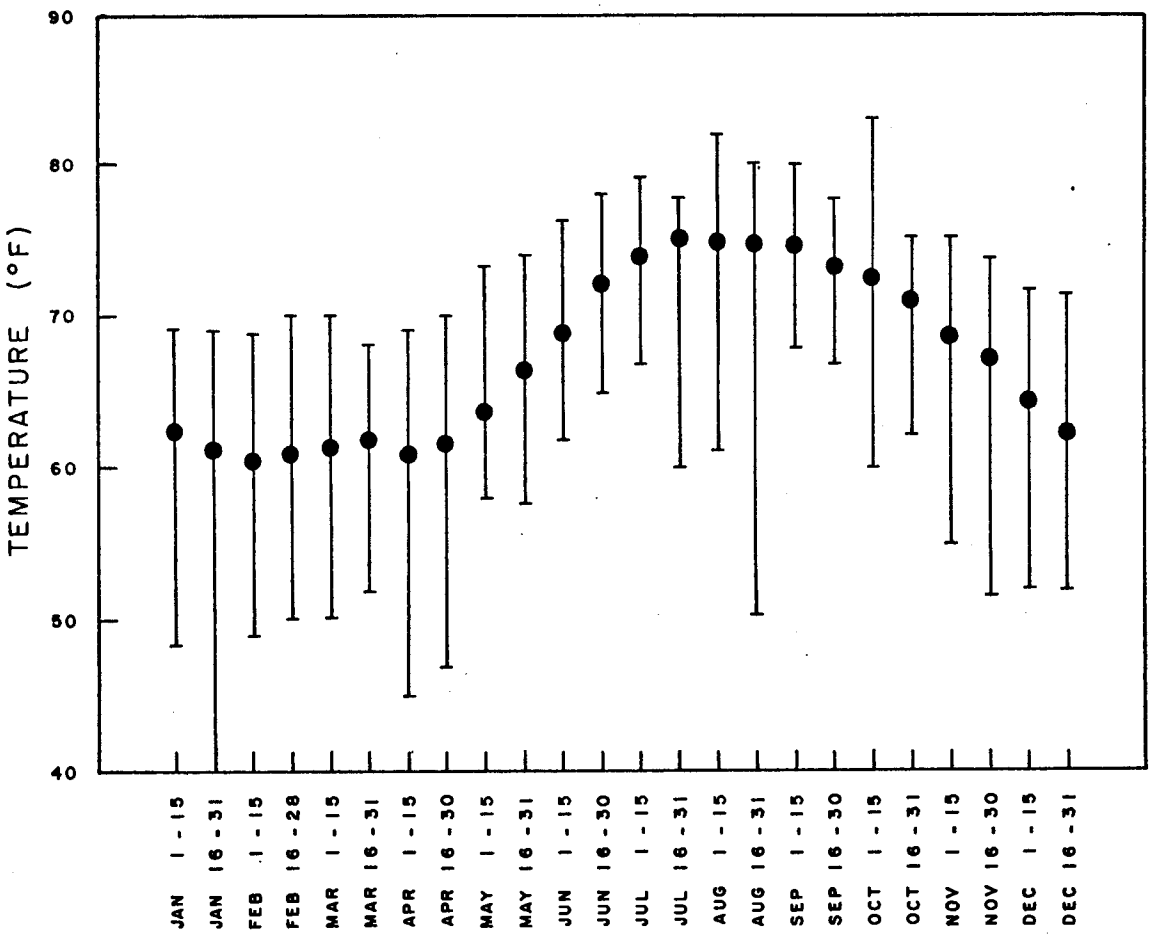



Figure 21. Average semimonthly minimum temperatures and ranges at Kure Atoll, 1961-68. (From Woodward, 1972.)

Aleutian low, while in the northwestern end of the chain the influence of this low pressure is relatively great. As a result, winter temperatures at Kure-Midway are generally cooler, and winds have a more westerly component than at French Frigate Shoals.

The mean annual temperature at French Frigate Shoals is 75.5°F, and the mean annual range is ±5°F. From December through April the means are between 71° and 74°F, and during the rest of the year between 75° and 80°F. The warmest months are August and September and the coolest February and March. A 37°F difference exists between the extreme high of 91°F and the extreme low of 54°F at French Frigate Shoals. At Kure Atoll the extreme difference is 60°F (39° to 99°F). Figure 22 shows the monthly means and ranges of temperature at French Frigate Shoals for the 12-year period, 1950-1962.

The maximum sustained wind record for French Frigate Shoals for the 12-year period was 52 knots east-northeast in December. Annual mean wind speed was 12.6 knots, with a range of 5 knots. Mean monthly wind speeds were higher than the annual mean from November through April and lower from March through October. Figure 23 shows the direction and wind speed for each seasonal period for the 12-year period.

Mean monthly precipitation in inches and the mean number of days with measurable precipitation are shown in Figures 24 and 25, respectively. The mean annual precipitation over the 12-year period was 45.29 inches. Rainfall was heaviest from December through May and lightest from April through November. Measurable precipitation occurred on at least 16 days each month.

## ADDITIONAL DETAILED WEATHER INFORMATION

The U.S. Naval Weather Service Command publishes a *Summary of Synoptic Meteorological Observations* that lists very detailed weather information, including conditions at French Frigate Shoals and Midway Islands. Copies of these summaries may be obtained from the National Technical Information Service (NTIS), Springfield, Virginia 22151. These volumes are also available in the Government Documents Section, Hamilton Library, University of Hawaii. The complete reference for these synopses is:

U.S. Naval Weather Service Command
1971
*Summary of Synoptic Meteorological Observations*
Volume 1, Area 4 - French Frigate Shoals, pp. 475-632
Volume 2, Area 6 - Midway Islands, pp. 159-316

The data available in these summaries are listed below:

1. Percentage frequency of weather occurrence by wind direction
2. Percentage frequency of wind direction by speed and by hour
3. Percentage frequency of wind speed by hour
4. Percentage frequency of total cloud amount by wind direction
5. Percentage frequency of ceiling heights and occurrence of low cloud amounts <5/8 by wind direction

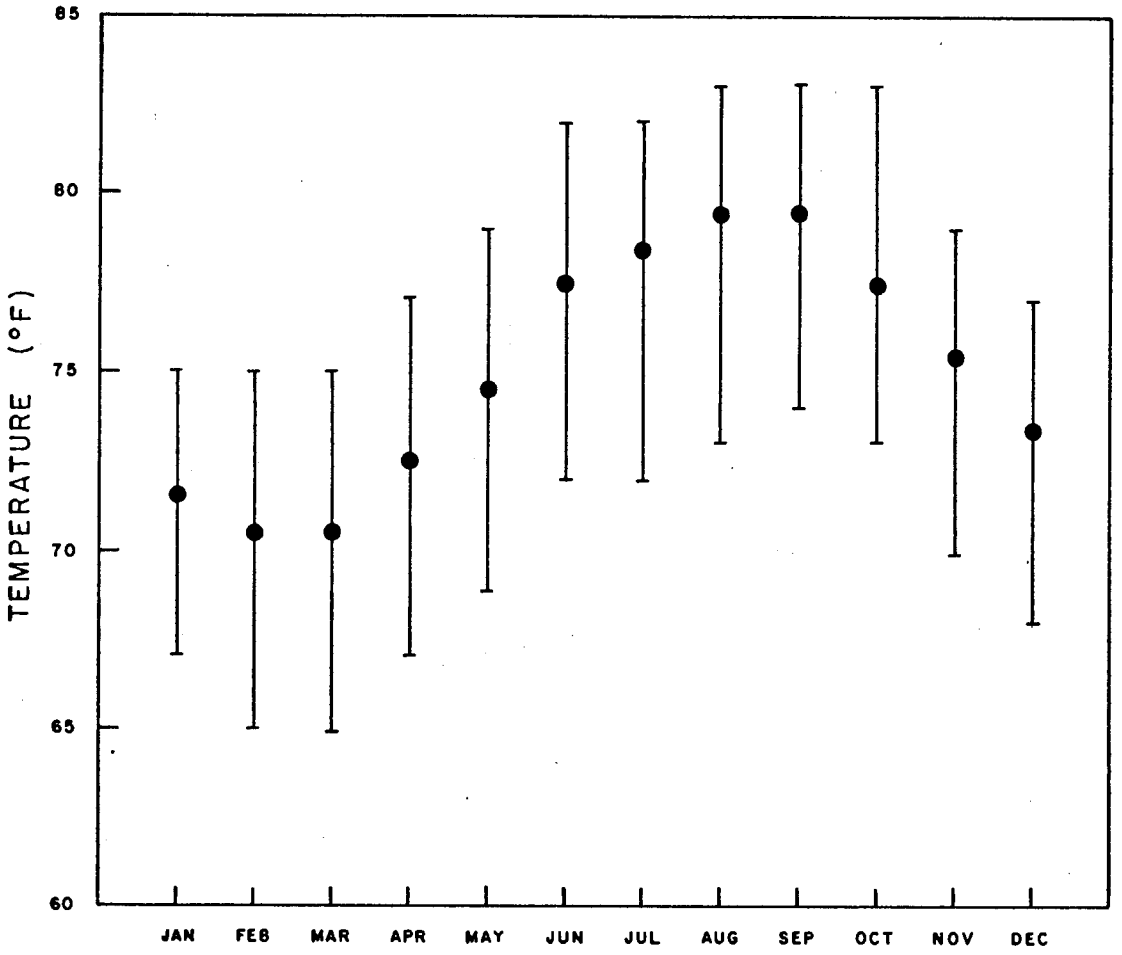



Figure 22. The mode of the monthly means for a 12-year period, December 1950 to December 1962, and the range of the maximum and minimum modes of temperature for French Frigate Shoals.

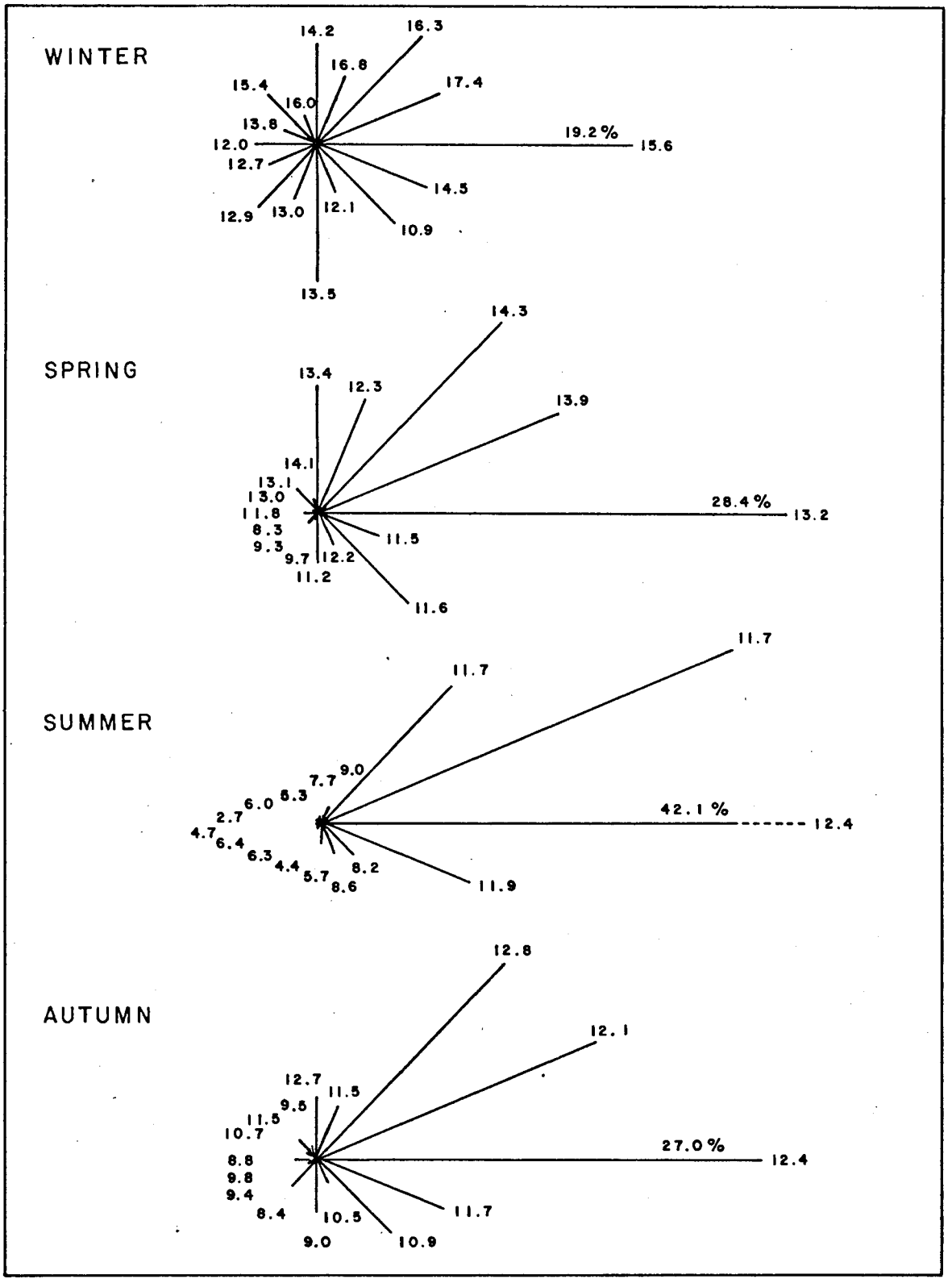



Figure 23. Wind direction and speed at French Frigate Shoals from December 1950 to December 1962. Length of directional line indicates percentage of observations from that direction; figure at end of directional line is mean wind speed in knots.

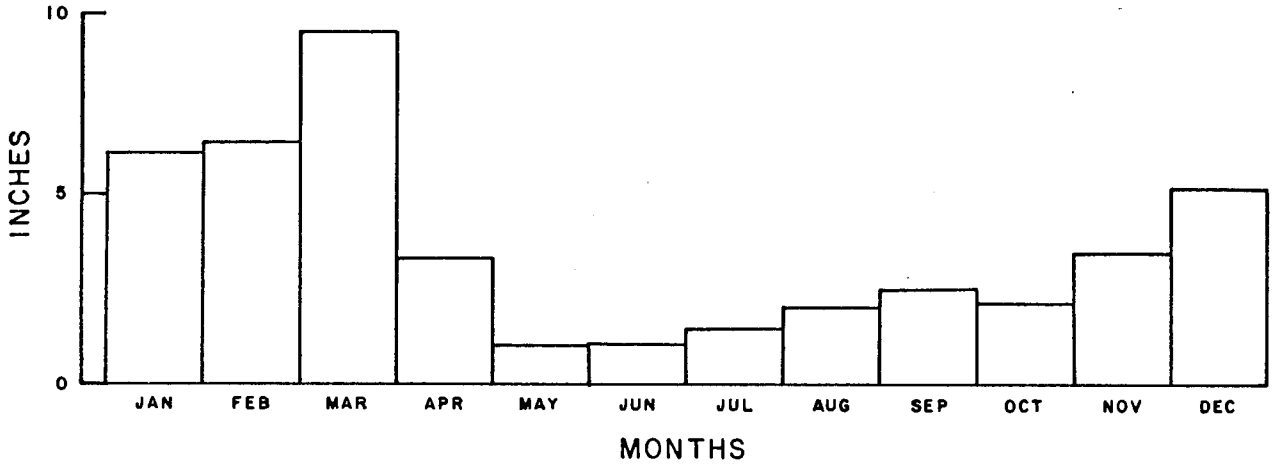



Figure 24. Mean monthly precipitation in inches for French Frigate Shoals, June 1954 to January 1960, March 1960 to December 1962

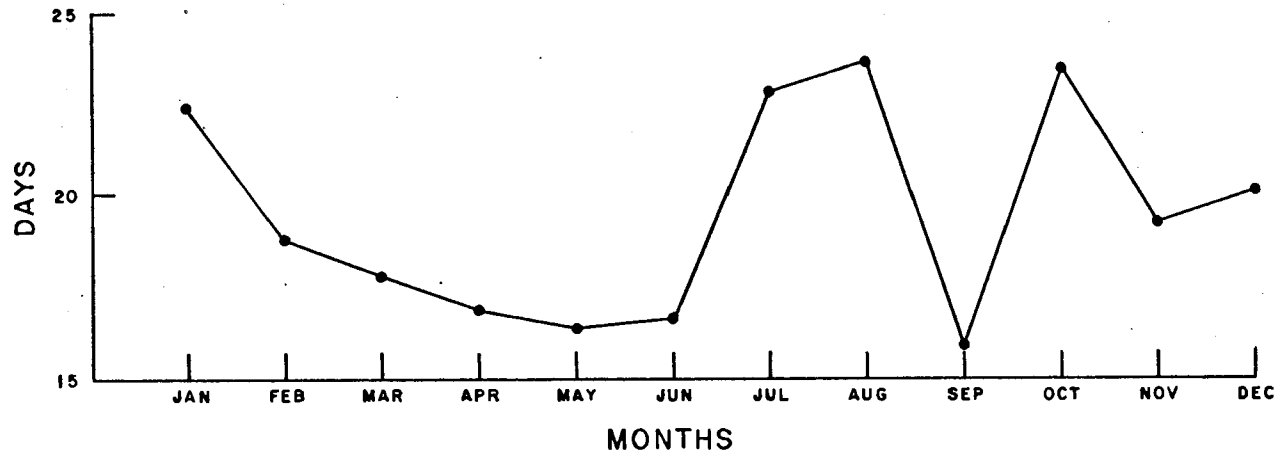



Figure 25. Mean number of days with measurable precipitation for French Frigate Shoals, June 1954 to January 1960, March 1960 to December 1962

6. Cumulative percentage frequency of simultaneous occurrence of ceiling height (low clouds >4/8) and visibility
7. Percentage frequency of low clouds
8. Percentage frequency of wind direction versus occurrence or non-occurrence of precipitation with varying values of visibility
9. Percentage frequency of wind direction versus wind speed with varying values of visibility
10. Percentage frequency of ceiling heights and occurrence of low clouds >5/8 by hour
11. Percentage frequency visibility by hour
12. Cumulative percentage frequency of ranges of visibility and/or ceiling height by hour
13. Percentage frequency of relative humidity by temperature
14. Means, extremes, and percentiles of temperature (°F) by hour
15. Percentage frequency of wind direction by temperature
16. Percentage frequency of relative humidity by hour
17. Percentage frequency of air temperature (°F) and the occurrence of fog (without precipitation) versus air-sea temperature difference (°F)
18. Percentage frequency of wind speed (knots) and direction versus sea heights
19. Percentage frequency of wave height (feet) versus wave period (seconds)

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